FISHERY MANAGEMENT INVESTIGATIONS

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SALMON REGION 2017

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

HIGH MOUNTAIN LAKES: STOCKING AND SURVEYS - 2017

ABSTRACT

Regional fisheries staff coordinated with Mackay Fish Hatchery and Sawtooth Flying Service to stock 35,096 fish in 60 high mountain lakes in the Salmon Region in 2017. A total of 40 lakes were stocked with 23,252 Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, 13 lakes with 9,926 Arctic Grayling *Thymallus arcticus*, six lakes with 1,317 triploid Rainbow Trout *O. mykiss*, and one lake with 601 Golden Trout *O. mykiss aguabonita.* Aerial stocking in 59 of the 60 lakes took place between August 25 and September 1, 2017, and backpack stocking for Hindman Lake #1 took place on September 12. Flight costs totaled $5,842.50 for 2017.

In 2017, we surveyed 57 high mountain lakes to determine fish presence, species composition, relative abundance, and evaluated fish growth and condition (W_r). We found fish present in 41 (72%) of the 57 waterbodies sampled. Westslope Cutthroat Trout were found in 26 lakes, Rainbow Trout were found in 10 lakes, apparent Cutthroat x Rainbow Trout hybrids were found in four lakes, Arctic Grayling were found in three lakes, and Golden Trout were found in one lake.

We also performed visual amphibian surveys at most lakes in 2017. Amphibians were found in 16 (30%) of the 53 waterbodies where we performed amphibian surveys. Amphibians were found in 19% of surveyed lakes containing fish, and 56% of fishless lakes.

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INTRODUCTION

Anglers fishing high mountain lakes in Idaho have consistently expressed high satisfaction with their angling experience (IDFG 2019). High mountain lakes offer diverse angling opportunities in scenic areas, and are an important contributor to the state's recreational economy.

Stocking hatchery trout plays a vital role in managing high mountain lake fisheries. Of over 1,000 Salmon Region high mountain lakes, 189 are currently stocked on a three-year rotation, and four are stocked annually. Idaho Department of Fish and Game (IDFG) primarily stocks four species of fry (TL <76 mm) in high mountain lakes: Arctic Grayling *Thymallus arcticus* (GRA), Golden Trout *Oncorhynchus aguabonita* (GN), triploid Rainbow Trout *O. mykiss* (RBT), or Westslope Cutthroat Trout *O. clarkii* (WCT). In rare circumstances, IDFG also periodically stocks predator species (i.e. tiger muskellunge *Esox masquinongy x Esox Lucius* [TM] or tiger trout *Salmo trutta x Salvelinus fontinalis*) in some high mountain lakes to reduce abundance of other fish species (i.e. Brook Trout *Salvelinus fontinalis* [BT]). The three-year stocking rotation maintains a diverse size structure of fish and ensures fish populations persist in mountain lakes where natural reproduction is not sufficient to maintain fishable populations. The stocking rotation list is adjusted annually to reflect the most currently available survey information and current management goals.

As of September, 2017, one-hundred and eighty-nine (189) high mountain lakes throughout the Salmon Region are currently stocked on a three-year rotation. Stocking these lakes helps provide fishing opportunity in places that may not otherwise support fish persistence (i.e. lack of natural reproduction). In 2015, we began an intensive three-year evaluation of the effectiveness of our current high mountain lake stocking program. Over a three year period (2015-2017), we have surveyed a large number of our stocked high mountain lakes to assess fish growth, species composition, and relative abundance (catch per unit effort [CPUE]), similar to what has been done previously in the Panhandle region (Fredericks et al. 2002, Fredericks et al. 2009). Study results will be used to influence stocking decisions (i.e. density, species, or frequency) to improve fishing quality in these high mountain lakes.

OBJECTIVES

Mountain Lake Stocking

1. Provide diverse high mountain lake fisheries throughout the Salmon Region (i.e. diverse species and size structure), with emphasis placed on high-use areas where natural reproduction does not occur.

Mountain Lake Surveys

2. Assess fish growth and relative abundance in stocked high mountain lakes, and adjust future stocking recommendations based on those results.

3. Identify high mountain lakes that currently support naturally reproducing fish populations, and determine whether natural reproduction is adequate for maintaining those fisheries.

STUDY AREA

The Salmon Region contains more than 1,000 high mountain lakes. These range from small ponds that are less than one hectare in size to 70 ha Sawtooth Lake #1 in the Stanley Basin. Regional high mountain lake elevations range from 1,970 to over 3,000 m. We estimate that nearly 400 high mountain lakes in the Salmon Region provide fishing opportunity, either aided by stocking or as a result of natural reproduction. Further information on each specific lake that was surveyed in 2017 can be found in the results section of this chapter.

METHODS

Mountain Lake Stocking

High mountain lake stocking densities and species requests are coordinated between regional staff and Mackay Fish Hatchery staff each spring. Fish are hatched and reared at Mackay Fish Hatchery, who coordinates with the contracting aviation company (Sawtooth Flying Service, McCall, ID) to stock the lakes with the correct species and numbers of fish. As of September 2017, 58 lakes are requested to be stocked on rotation A, 76 lakes on rotation B, and 55 lakes on rotation C. Actual stocking can vary from the request in some years, due to a surplus or deficit in fish, or to accomplish specific management objectives. Rotation A lakes were requested to be stocked in 2017 (Table 1). Each stocking rotation usually requires multiple flights and/or days to complete. Flight routes for each rotation were refined in recent years to keep flight time and fuel costs efficient. Further details of regional aerial stocking methodology were reported in Flinders et al. (2013).

Aerial stocking in 59 of the 60 lakes took place between August 25 and September 1, 2017, and backpack stocking for Hindman Lake #1 took place on September 12. Flight costs totaled $5,842.50 for 2017, equating to roughly $99 per lake.

Mountain Lake Surveys

Rotation B lakes (stocked in 2015) were targeted for surveys in 2017. Salmon Region fisheries staff surveyed 57 high mountain lakes and ponds in the Upper Salmon River drainage in 2017. Thirty-eight of the 57 lakes we surveyed in 2017 were stocked in 2015 on rotation B, and the other 19 lakes reported here were opportunistically surveyed. We sampled fish communities at 39 of the 57 lakes using one sinking-style mountain lake gill net fished overnight. Fish presence was estimated at the other 18 lakes we surveyed by a combination of angling and visual surveys. Monofilament gill nets were 36-m long by 1.8-m deep, and composed of six panels of 10.0-, 12.5-, 18.5-, 25.0-, 33.0-, and 38.0-mm mesh. We used sinking-style gill nets for all gill net surveys. Captured fish were measured to the nearest mm total length (TL) and weighed in grams (g). Mean total lengths for each species, at each lake, and standard errors (± SE) were calculated. Relative weights (W_r) were also calculated for fish larger than 130 mm TL using the standard weight (W_s) equation:

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

where *a* = the intercept value and *b* = slope derived from Blackwell et al. (2000) (Appendix A). We used Rainbow Trout slope and intercept values for Arctic Grayling also, since Blackwell et al.

(2000) did not offer any for Arctic Grayling. The log value is then converted back to base 10, and relative weight is then calculated using the equation:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

Sagittal otoliths were collected from three to five fish in each 10 mm size class for age-structure analysis. Otoliths were prepared for sectioning at the Salmon regional office, then we sectioned and digitized them at the Idaho Falls (Region 6) Fish and Game office. Cross-sectioned otoliths were photographed at 40x magnification and read by two independent readers. Discrepancies in age estimates between readers were settled by a third reader.

Survey crews visually and subjectively assessed fish spawning potential and the presence of natural reproduction at each lake based on the presence of redds, fry, and/or fingerlings. Potential natural reproduction was also determined based on fish age distribution derived from otoliths, compared with stocking events. Physical characteristics of each lake, weather conditions at the time of survey, access information, and the amount of human use were also recorded. Human use was subjectively classified as none, low, moderate, or high based on visual observation. A depth profile of the lake was also performed when time allowed, by traversing the lake in a floating packraft and recording GPS waypoints and depths, taken using a handheld depth finder (Hondex PS-7).

At each lake, we assessed presence and relative abundance of amphibians using a modification of the timed visual encounter survey (VES) (Crump and Scott 1994). The main deviation from the VES methodology was that the survey crew performed a full perimeter search without accounting for various habitat types. Survey data was entered into the statewide ‘Lakes and Reservoirs’ database.

RESULTS AND DISCUSSION

Mountain Lake Stocking

Sixty rotation A high mountain lakes were stocked in 2017. In total, 40 lakes were stocked with 23,252 Westslope Cutthroat Trout (WCT), 13 lakes with 9,926 Arctic Grayling (GRA), six lakes with 1,317 triploid Rainbow Trout (RBT), and one lake with 601 Golden Trout (GNT) (Table 2).

Mountain Lake Surveys

We surveyed 57 lakes in 2017 (Table 3).

Alpine Creek Lakes

Alpine Creek Lakes – There are 52 lentic waterbodies in the Alpine Creek Lakes basin; ten lakes and a large number of intermittent ponds. Ten lakes in the Alpine Creek Lakes basin are currently stocked on rotation B (#2, #4, #5, #6, #7, #11, #12, #13, #14, and #15) – all of which were stocked in 2015. Stocking began in the Alpine Creek Lakes basin in 1967, with Cutthroat Trout in lakes #1, #2, #3, #4, #5, #7, #8, #10, and #11. Cutthroat Trout have been the most common species stocked in the Alpine Creek Lakes Basin over the years, but several lakes have also been stocked intermittently with Golden Trout (#10 and #11), Grayling (#4, #5, #10, #11, #13, #14, and #15), and Rainbow Trout (#4, #5, #11, and #14). Alpine Creek Lakes #2, #6, and #7 are currently stocked with Westslope Cutthroat Trout on a 3-year rotation, Alpine Creek Lakes #4, #13, #14, and #15 are currently stocked with Grayling on a 3-year rotation, and Alpine Creek Lakes #5 and #11 are currently stocked with Rainbow Trout on a 3-year rotation (Table 3). Human use is relatively rare to moderate in the Alpine Creek Lakes basin (Table 4). Although the trailhead is in a fairly popular area (Alturas Lake Inlet), access to each one of the Alpine Creek Lakes require at least some cross-country navigation, which likely reduces visitor volume. Several campsites are present at some of the lower lakes. The Alpine Creek Lakes were surveyed between August 2 and August 7, 2017.

Alpine Creek Lake #2 – One gill net was set at Alpine Creek Lake (ACL) #2 for 13.5 h and did not catch any fish (Table 5). Westslope Cutthroat Trout were stocked in 2015, and during our survey in 2017, we observed fish carcasses scattered throughout the lake bottom, suggesting a recent fish kill. The only other time this lake has been surveyed (2001), results were similar. Surveyors estimated maximum depth in the lake at 3.4 m, which seems adequate for supporting overwintering fish in most years, but perhaps occasional winterkills are still possible. We recommend removing this lake from the stocking rotation (Table 6) as it does not seem to support fish consistently, and rarely sees human use (Table 4). No amphibians were observed in 2017 (Table 5).

Alpine Creek Lake #4 – One gill net was set in Alpine Creek Lake #4 for 14.0 h and caught 17 WCT (CPUE = 1.21 fish/h; Table 3). Total length of WCT ranged from 154 mm to 400 mm, with an average of 276 mm (± 17.4, *n*= 17) (Table 3, Figure 1). Relative weights were below 100 for all size classes of fish (mean W_r = 81.3, range, 56.5–94.6) (Figure 1). WCT have not been stocked in ACL #4 since 2001, so natural reproduction is certainly occurring, and supporting the majority of fish abundance in this lake. GRA stocked at the current (low) density seems to contribute very little (if at all) to this fishery (Table 3). Length-at-age information suggests WCT growth rate is relatively high (Figure 2), so this lake may be able to support a higher abundance of fish, if stocking rate was increased. We recommend increasing the stocking rate for GRA in 2018 (Table 6). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #4A and #4B – We did not fish or set gill nets in these lakes in 2017, but visually observed fish in both of them as we walked by. Both of these small ponds are well connected with Alpine Creek Lake #4, and also receive water input from other Alpine Creek Lakes above them (#5 and #6). These ponds are not currently stocked, and should not be added to the stocking rotation due to their small size. However, they do provide angling opportunity during summer months. Neither of these ponds were surveyed for amphibians in 2017 (Table 3).

Alpine Creek Lake #5 - One gill net was set in Alpine Creek Lake #5 for 17.5 h and caught two RBT x WCT hybrids (CPUE = 0.11 fish/h; Table 3). Total length of the two fish caught was 449 and 465 mm (Table 3, Figure 1). Relative weights were 81.3 and 71.6, respectively (Figure 1). This lake was stocked with triploid Rainbow Trout in 2015, but none were collected in 2017. The hybrids we captured in 2017 appeared to be relatively old (Figure 2). The last two times this lake was surveyed (1973 and 2001), smaller fish were observed, but for some reason we did not find smaller fish from the 2015 stocking event during our survey in 2017. We recommend leaving this lake on the stocking rotation with triploid Rainbow Trout, as the lake would likely provide excellent growth rates if stocked fish were able to survive (Table 6). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #6 - One gill net was set in Alpine Creek Lake #6 for 13.7 h and caught 13 WCT (CPUE = 0.95 fish/h; Table 3). Total length of WCT ranged from 161 mm to 378 mm, with an average of 247 mm (± 18.7, *n* = 13) (Table 3, Figure 1). Relative weights averaged 100.9 for all size classes of fish (range, 86.1 – 113.7), but were generally below 100 for larger fish (Figure 1). Natural reproduction may be occurring in this lake, but perhaps is not successful every year (Figure 2). Increasing stocking density could help increase overall fish abundance and improve catch rates, but due to the relatively low level of human use at Alpine Creek Lake #6 (Table 4), we recommend maintaining the current stocking regime (Table 6). This lake currently offers moderate catch rates and allows for excellent growth rates (Figure 2). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #7 - One gill net was set in Alpine Creek Lake #7 for 16.3 h and caught 14 WCT (CPUE = 0.86 fish/h; Table 3). Total length of WCT ranged from 225 to 358 mm, with an average of 308 mm (± 8.1, *n* = 14; Table 3, Figure 1). Relative weights were generally below 100 for all size classes of fish (mean W_r 80.9; range, 64.4 – 101.7; Figure 1). Natural reproduction is likely occurring in this lake as indicated by the presence of age classes of trout that do not reflect stocking history (Figure 2), but perhaps is not successful every year. This lake provides moderate catch rates (Table 3) and growth is good (Figure 2). Recommend maintaining the current stocking rate (Table 6). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #11 - One gill net was set in Alpine Creek Lake #11 for 17.8 h and caught six RBT, three GNT, and two GRA (combined CPUE 0.62 = fish/h; Table 3). Total length of RBT ranged from 180 to 339 mm, with an average of 296 mm (± 24.7, *n* = 6), GNT ranged 251 to 335 mm TL and averaged 298 mm, and GRA were 333 and 374 mm TL (Table 3, Figure 1). Relative weights were below 100 for all size classes of fish (mean W_r = 72.5, range, 59.7–93.2; Figure 1). Natural reproduction does not appear to be occurring for GRA or RBT, as ages reflect stocking events in 2006 for GRA and in 2012 and 2015 for RBT (Figure 2). However, natural reproduction does appear to be occurring for GNT, as ages reflect years when they were not stocked (only stocked in 2001 and 2016; Figure 2). This lake currently provides diverse species composition and size structure, which would be beneficial to maintain for angler opportunity. However, RBT are the only species currently set to be stocked in 2018, and there are no younger age classes of GRA in the lake at the present time. RBT were stocked in 2015 and GNT were stocked in 2016, so in 2018, we recommend stocking both RBT and GRA (Table 6). This will ensure GRA persist in the lake to continue offering anglers a unique opportunity to catch several species in the same lake. No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #12 - One gill net was set in Alpine Creek Lake #12 for 6.8 h and caught two WCT (CPUE = 0.30 fish/h; Table 3). Total length of WCT was 281 mm and 284 mm (Table 3, Figure 1). Relative weights were 84.4 and 91.5 (Figure

1). Natural reproduction does not appear to be occurring in this lake, as evidenced by age structure comparisons with stocking history (Figure 2). Survival of stocked fish may vary among stocking years as well, as both of the fish we caught appeared to originate from a single stocking event in 2009 (Figure 2). However, numerous smaller fish were observed in the lake, but were not captured in the gill net. Alpine Creek Lake #12 is very small (0.4 ha) but seems deep enough to support fish persistence (3.4 m max depth) at least for a few years. . This lake likely sees very little human use (Table 3), but maintaining the current stocking frequency and density does provide opportunity for infrequent visitors. Recommend no stocking change (Table 6). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #12A – We did not fish or set gill nets in this lake/pond in 2017, but visually observed an abundance of small fish while surveying nearby lakes. It appears fish can easily move between this pond and others in the vicinity. This pond is not currently stocked, and should not be added to the stocking rotation. No amphibian survey was conducted in 2017 (Table 3).

Alpine Creek Lake #13 - One gill net was set in Alpine Creek Lake #13 for 15.5 h and caught 34 GRA and one WCT (combined CPUE = 2.26 fish/h; Table 3). Total length of GRA ranged from 197 to 382 mm, with an average of 338 mm (± 6.4, n = 34) and the WCT measured 422 mm TL (Table 3, Figure 1). Relative weights were well below 100 for all size classes of GRA (mean W_r = 59.1, range, 41.4–69.5) and the WCT relative weight was 86.2 (Figure 1). WCT have not been purposely stocked in this lake as far as our records show, so the WCT we caught this year either colonized the lake from downstream or were stocked by mistake. Natural reproduction is certainly occurring for GRA. We captured nearly all age classes of GRA from age-4 to age-13 (Figure 2). Growth rate information suggests GRA reach nearly maximum length by age-6, and grow very slowly after that point. However, the length they attain by age-6 (~350 mm TL) in this lake is relatively high for high mountain lake GRA, and the relatively high abundance present in this lake provides opportunity for excellent catch rates. Recommend no stocking change (Table 6). No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #14 - One gill net was set in Alpine Creek Lake #14 for 13.5 h and caught 21 GRA and four WCT (combined CPUE = 1.90 fish/h; Table 3). Total length of GRA ranged from 108 to 356 mm, with an average of 248 mm (± 17.8, n = 21) and WCT ranged from 100 to 315 mm TL, with an average of 211 mm (± 49.4, n= 4; Table 3, Figure 1). Relative weights were below 100 for all size classes of GRA (mean W_r = 82.3, range, 71.6–94.9), but near 100 for all WCT (mean W_r = 99.8, range, 92.6–104.7; Figure 1). We do not have record of WCT ever being stocked in this lake, but they could certainly colonize the lake from other nearby lakes. With the relatively low WCT abundance we observed in this lake, colonization is the likely source. GRA natural reproduction is likely occurring, as indicated by the presence of age classes of GRA that do not reflect stocking history (Figure 2). Despite the presence of natural reproduction, GRA growth rate is relatively high compared to ACL #13 (Figure 2). This lake is one of the lowest (in elevation) in the basin and likely sees relatively higher angler visitation as a result. Since GRA appear to be self-sustaining via natural reproduction, we recommend stocking WCT at a low density to supplement their abundance (Table 6), and manage this fishery for diverse species assemblage with higher than average catch rates. No amphibians were observed in 2017 (Table 3).

Alpine Creek Lake #15 - One gill net was set in Alpine Creek Lake #15 for 10.5 h but did not yield any fish (Table 5). One fish was in the gill net but fell out during net retrieval. GRA have been stocked in this lake approximately once every three years since 1988. During a survey in 2014, GRA were observed, but in fairly low abundance. A survey in 2001 did not find any fish. For some reason, GRA don't appear to survive well in this lake. We removing this lake from the stocking rotation to put stocking resources where they may be better utilized (Table 4).

Vanity Summit Area

Baldwin Creek Lake – According to our records Baldwin Creek Lake was first stocked in 1961 with Rainbow Trout, but has been stocked exclusively with WCT approximately once every three years since then. The only prior survey record we have for Baldwin Creek Lake was in 2007, when both RBT and RBT x WCT hybrids were observed. In 2017, the survey crew estimated that human use was rare, since access is solely cross-country and is approximately 6.4 km through heavily timbered, steep terrain (Table 4). Baldwin Creek Lake was surveyed on July 23 - 24, 2017.

Baldwin Creek Lake – One gill net was set in Baldwin Creek Lake for 13.3 h and caught six WCT and two RBT (combined CPUE = 0.60 fish/h; Table 3). Surveyors also fished the lake for a combined 4.0 h and caught two RBT and two WCT (CPUE = 1.00 fish/h). Gill-netted WCT ranged in length from 124 to 381 mm TL and averaged 274 mm (± 34.9, *n* = 6) and gill netted RBT measured 348 and 368 mm TL (Table 3, Figure 3). Fish caught during angling were not measured. Relative weights were generally below 100 for all size classes of both species, but were higher for WCT than for RBT (Figure 3). Mean relative weight for WCT was 92.5 (range, 82.5–96.2) and RBT relative weights were 61.1 and 78.3 (Figure 3). Natural reproduction appears to be occurring for both species. Surveyors in 2017 observed fish spawning in and near the outlet, and saw multiple redds along the shoreline. Although gill net catch rate was low, angling catch rate seems adequate, especially with relatively high growth rates (Figure 4). No stocking changes are recommended (Table 6). No amphibians were observed in 2017.

Bear Creek Lake – Bear Creek Lake #1 was first stocked in 1947 with Cutthroat Trout. Since 1966, it has been stocked approximately once every three years with either Cutthroat Trout or Rainbow Trout, and is currently stocked with WCT on a 3-year rotation. The only prior survey record we have for Bear Creek Lake #1 was in 2003, and no fish were observed during that survey. In 2017, the survey crew estimated that human use was high because it is located in a high-use area on Vanity Summit, and can be accessed by vehicle (Table 4). Bear Creek Lake #1 was surveyed on July 22 – 23, 2017.

Bear Creek Lake #1– One gill net was set in Bear Creek Lake #1 for 13.0 h and did not catch any fish (Table 5). Surveyors noted that several groups of anglers visited the lake while it was being surveyed, but caught nothing. One angler mentioned visiting the lake multiple times over the past decade and has never caught fish. Although this lake is small, maximum depth was estimated at 4.0 m, so the lake should be able to support fish in most years (Table 4). This lake could potentially provide relatively high growth rates for catchable RBT if they were stocked. We recommend stocking catchable RBT and evaluating overwinter survival one year later to determine if this is a feasible option for the fishery (Table 6). This would require regional staff meeting the hatchery truck to transport fish to the lake in a smaller tank. In the meantime however, we recommend to continue aerial stocking of WCT. No amphibians were observed in 2017 (Table 5).

Langer Lakes – There are five relatively larger lakes (Lower Island, Island, Ruffneck, Langer, and Rocky) and several small ponds in the Langer Lakes basin. These lakes have periodically been stocked since 1939 with both RBT and WCT, and currently all of the larger lakes except Rocky Lake are stocked on a 3-year rotation. Island Lake is stocked with ~1,500 RBT, Langer Lake #1 is stocked with ~1,000 RBT, Lower Island Lake is stocked with ~540 WCT, and Ruffneck Lake is stocked with ~1,200 RBT. Human use in the Langer Lakes basin is relatively high (Table 4). The lakes in this basin were surveyed July 17 – 19, 2017.

Island Lake - One gill net was set in Island Lake for 15.5 h and surveyors angled the lake for 1.3 combined h and caught no fish (Table 5). This is the first time in nine surveys, since 1966, that fish were not collected at Island Lake. We suspect the lake experienced a rare winterkill event during the severe winter of 2016/2017. Due to the relatively high level of use in the Langer Lakes basin, we recommend re-stocking with a moderate density of sterile RBT in 2018 (Table 6). Stocking sterile fish in the lake should help us manage fish abundance to maximize growth potential. Occasional evaluation of growth and abundance will be necessary to make educated adjustments. No amphibians were observed in 2017 (Table 5).

Langer Lake #1 - One gill net was set in Langer Lake #1 for 16.0 h and caught 13 WCT (CPUE = 0.81 fish/h; Table 3). Two hours of angling did not produce any additional fish. Total length of WCT ranged from 89 to 420 mm, and averaged 312 mm (± 30.5, n = 13; Table 3, Figure 3). Relative weights averaged 97.7 (range, 86.7–109.9; Figure 3). No RBT were caught in 2017, suggesting the group stocked in 2015 may not have survived well. WCT natural reproduction is occurring however (Figure 4), likely at a low rate. Under the current fish abundance and forage conditions, WCT are growing very well (Figure 4). However, at a lake with such relatively high human use, increasing fish abundance would likely be beneficial. We recommend discontinuing RBT stocking, and increasing stocking density for WCT to improve catch rates (Table 6). Western Toad *Bufo boreas* adults and egg masses were observed in 2017 (Table 3).

Lower Island Lake – One gill net was set in Lower Island Lake for 13.8 h and caught 45 RBT and 10 WCT (combined CPUE = 4.00 fish/h; Table 3). RBT ranged in length from 72 to 462 mm TL and averaged 149 mm (± 13.8, n = 45) and WCT ranged in length from 82 to 340 mm TL and averaged 128 mm (± 27.7, n = 10; Table 3, Figure 3). Relative weights were generally near 100 for all RBT larger than 200 mm TL, and were well above 100 for WCT (Figure 3). Mean relative weight for RBT was 93.4 (range, 82.2–108.6) and relative weight for the two WCT greater than 130 mm TL we caught was 120.0 and 123.5 (Figure 3). Rainbow Trout have never been stocked in Lower Island Lake, but could certainly colonize this lake from Island and Ruffneck Lake, which drain into Lower Island Lake. Length-at-age information shows that natural reproduction is present in the basin for RBT, but may not be occurring for WCT in Lower Island Lake (Figure 4). This lake doesn't seem to get as much human use as nearby Langer, Ruffneck, and Island, but can certainly provide quality fishing opportunity with both high catch rates and large fish. No stocking changes are recommended (Table 6). No amphibians were observed in 2017.

Rocky Lake – We did not set a gill net in Rocky Lake, but fished the lake for 2.0 h and did not catch any fish (Table 3). We found one large WCT dead along the shoreline that measured approximately 405 mm TL. This population of WCT appears to be very low in abundance. Although low abundance likely results in relatively high growth rates for WCT in this lake, the popularity of this area seems to warrant increasing stocking density to improve catch rates. We believe there may have been a significant winter kill event in the general Seafoam area in 2016/2017, as other lakes that are generally productive appeared fishless this year as well. Recommend increasing stocking density for WCT in 2018 (Table 6). One adult Long-toed Salamander *Ambystoma macrodactylum* was observed in 2017 (Table 3).

Ruffneck Lake – One gill net was set in Ruffneck Lake for 12.7 h and caught 29 RBT (CPUE = 2.29 fish/h; Table 3). Additionally, the crew fished the lake for 1.5 combined h and caught one RBT (CPUE = 0.67 fish/h). Total length of gill netted RBT ranged from 70 to 470 mm, with an average of 192 mm (± 24.6, *n* = 29; Table 3, Figure 3). Relative weights were below 100 for all size classes of fish (mean W_r 80.2; range, 71.0–89.9; Figure 3). Although relative weights are relatively low, length-at-age data suggests fish grow very well in this lake (Figure 4). The RBT we caught in 2017 reached in excess of 400 mm TL by age-6, and could exceed 500 mm TL by age-7 or age-8 (Figure 4). The survey crew noted that large fish (estimated larger than 500 mm TL) were observed swimming around in the lake, but they were too difficult to catch. It appears there may be some limited natural reproduction taking place in this lake, as indicated by the presence of age classes of trout that do not reflect stocking history (Figure 4). However, all RBT stocked since 2001 have been sterile, so any natural reproduction taking place is likely at a low level. At the current stocking density, this lake provides moderate catch rates and quality size trout. Recommend maintaining the current stocking rate (Table 6). No amphibians were observed in 2017 (Table 3).

Vanity Lakes – There are 13 lakes in the Vanity Lakes basin (#1 through #13). Most of these lakes have periodically been stocked with both RBT and WCT since 1949, and Vanity Lake #13 has been stocked periodically with Arctic Grayling since 1988. Currently, Vanity Lakes #1, #4, and #7 are stocked on a 3-year rotation with approximately 300, 250, and 200 Rainbow Trout respectively. Vanity Lake #5 is also stocked on a 3-year rotation with 115 Cutthroat Trout, and Vanity Lake #13 is stocked on a 3-year rotation with Arctic Grayling. Due to a shortage of Grayling at the hatchery in 2015, Vanity Lake #13 has not been stocked since 2013. Human use in the Vanity Lakes basin was generally estimated as rare to moderate (Table 4). Vanity Lakes #1, #3, #4, #5, #6, and #7 were surveyed from July 20 – 21, 2017.

Vanity Lake #1 – One gill net was set in Vanity Lake #1 for 14.8 h and caught 28 WCT and two RBT (combined CPUE = 2.03 fish/h), and 0.3 h of angling caught an additional one WCT (CPUE = 4.00 fish/h; Table 3). Gill netted WCT ranged in length from 105 to 286 mm TL and averaged 199 mm (± 11.6, *n* = 28) and gill-netted RBT measured 230 and 420 mm TL (Table 3, Figure 3). Fish caught during angling were not measured. WCT relative weights varied widely across the sample (range, 65.7–130.9) but averaged 98.9, and RBT relative weights were 94.7 and

63.3, respective to the lengths mentioned previously (Figure 3). Natural reproduction appears to be occurring for WCT but not for RBT, as the only RBT we observed corresponded to stocking events in 2012 and 2015 (Figure 4). This is likely to be the most heavily used of the Vanity Lakes, and thus high catch rates are generally preferred for this type of fishery. It appears WCT natural reproduction could likely sustain quality catch rates at this lake, and stocking RBT does not provide much in the way of additional opportunity. We recommend ending stocking for RBT at this lake (Table 6) to determine if natural reproduction of WCT is sufficient for maintaining the fishery. No amphibians were observed in 2017.

Vanity Lake #3 – This lake was not surveyed with gill nets or angling in 2017, but fry were visually observed in the inlet, and small fish were observed occasionally surfacing in the open water to capture insects. We have not stocked this lake since 2000, so although no larger fish were observed in 2017, natural reproduction must be occurring. During past surveys in 1972 and 2002, WCT were observed in the lake, none over 300 mm. We recommend not changing stocking practices at this lake until fish abundance and age/growth can be evaluated. This lake appears to possess good amphibian habitat, and one Columbia Spotted Frog was observed during the walk in 2017 (Table 5).

Vanity Lake #4 – One gill net was set in Vanity Lake #4 for 19.0 h and caught six RBT and two RBT x WCT hybrids (combined CPUE = 0.42 fish/h), and 5.0 h of angling caught an additional one RBT and one RBT x WCT hybrid (CPUE = 0.40 fish/h; Table 3). Gill netted RBT ranged in length from 117 to 443 mm TL and averaged 302 mm (± 59.0, n = 6) and gill-netted RBT x WCT measured 304 and 310 mm TL (Table 3, Figure 3). Fish caught during angling were not measured. Relative weights for all fish captured were generally below 100, averaging 75.4 (range, 67.2–82.8; Figure 3). Natural reproduction appears to be occurring based on ageing data (Figure 4), but probably at a relatively low rate. This population appears to be fairly low in abundance, likely contributing to its ability to grow quickly (Figure 4) and reach relatively large sizes. The fishery is currently functioning well and provides opportunity for quality size fish. We recommend no change at this time (Table 6). Of note, the RBT stocked in this lake in 2015 were marked with a fin clip to link them to that stocking event, but we did not capture any trout with fin clips in 2017. We will re-evaluate in 2018, but if this lake appears to be self-sustaining, it may be desirable to remove it from the stocking rotation. No amphibians were observed in 2017.

Vanity Lake #5 – One gill net was set in Vanity Lake #5 for 13.5 h and caught no fish (Table 5). This is the first time in three surveys, since 1972, that fish were not collected at Vanity Lake #5. Additionally, we contacted a nearby angler that stated he has caught large trout here in the past. Perhaps the lake experienced a rare winterkill event during the winter of 2016/2017, as this is our only plausible explanation. We estimated maximum lake depth at 5.1 m, which should be sufficient to support fish year-round. We recommend continuing with the current WCT stocking rotation (Table 6). No amphibians were observed in 2017 (Table 5).

Vanity Lake #6 – We did not set a gill net in Vanity Lake #6 but fished the lake for a combined 3.0 h and caught 12 WCT and one RBT (combined CPUE = 4.33 fish/h; Table 3). None of the fish we captured during angling were measured. This lake is connected to Vanity Lake #7 via joined outlets, and there is abundant spawning habitat in the outlets. Surveyors noted several redds, as well as small fry/fingerlings at the lake in 2017. This lake is not currently stocked, and does not seem to require any stocking, so no changes are recommended. One adult Columbia Spotted Frog was observed in 2017 (Table 3).

Vanity Lake #7 – One gill net was set in Vanity Lake #7 for 16.3 h and caught one WCT (CPUE = 0.06 fish/h) measuring 266 mm TL (Table 3). This lake is approximately 3.0 m deep and currently holds very few fish. However, the last time it was surveyed, in 2002, surveyors noted the lake produced a great fishery with high abundance and quality size RBT. This lake, among a number of other lakes we surveyed in 2017, seems to have winterkilled at least partially, and significantly reduced the trout population. We recommend continuing on the current stocking regime (Table 6) to reestablish the previously existing fishery and re-evaluating in the future. We observed one adult Western Toad in 2017.

Float Creek Drainage

Harlan Creek Lakes – There are three lakes (Harlan Creek Lakes #1 - #3) and several smaller ponds in the Harlan Creek basin. According to IDFG historical stocking records, Harlan Creek Lakes #1 and #2 were first stocked with Cutthroat Trout in the 1960s, and have been stocked intermittently with Cutthroat Trout ever since. Harlan Creek Lakes #1 and #2 are currently stocked with approximately 250 and 300 Cutthroat Trout, respectively, on a 3-year rotation. Harlan Creek Lake #3 has never been stocked. The Harlan Creek Lakes were classified as receiving a relatively low level of human use in 2017 (Table 4). These lakes were surveyed August 5 – 6, 2017.

Harlan Creek Lake #1 – One gill net was set for 12.5 h and caught 19 WCT (CPUE = 1.52 fish/h; Table 3). Total length of WCT ranged from 192 mm to 388 mm, with an average of 306 mm (± 17.4, n = 19; Table 3, Figure 5). Relative weights averaged 92.3 (range, 76.6–113.4; Figure 5). The last time this lake was surveyed, in 2001, only small Cutthroat Trout were observed. In 2017, both size and abundance of WCT caught in the lake seemed adequate for maintaining a low-use fishery, so no changes are recommended (Table 6). No amphibians were observed in 2017 (Table 3).

Harlan Creek Lake #2 – One gill net was set for 16.5 h and did not catch any fish (Table 5). WCT were observed the last time the lake was surveyed in 2001, when they were stocked the year prior, but perhaps this lake winterkilled in 2017 similar to other lakes in the area. This lake has produced quality size trout in previous years, so we recommend continuing with the current stocking density for now (Table 6). No amphibians were observed in 2017 (Table 3).

Hasbrook Lakes – There are three lakes in the Hasbrook Basin (#1 - #3). According to our records, Hasbrook Lake #1 is the only lake that has been stocked, and was first stocked in 1975 with Cutthroat Trout. Hasbrook Lake #1 has intermittently been stocked with Cutthroat Trout ever since, and is currently stocked with approximately 375 WCT on a 3-year rotation. The last survey we conducted at Hasbrook Lake #1 (2001) found naturally reproducing trout that did not attain a large maximum size. In 2017, the survey crew estimated that human use was low (Table 4). Hasbrook Lake #1 was surveyed on August 18, 2017.

Hasbrook Lake #1 – One gill net was set for 13.0 h and caught 35 WCT (CPUE = 2.69 fish/h; Table 3). Total length of WCT ranged from 96 to 312 mm, with an average of 237 mm (± 7.3, *n* = 35; Table 3, Figure 5). Relative weights averaged 91.8 (range, 77.8–109.6; Figure 5). Natural reproduction is certainly taking place in this lake, and size distribution reflects the high density and slow growth rates (Figure 6). Stocking 375 WCT every three years in this lake is likely not contributing much to the quality of the fishery, and with low angler use (Table 4), we recommend discontinuing stocking to put those fish to better use elsewhere (Table 6). No amphibians were observed in 2017 (Table 3).

Helldiver Lake – According to IDFG records, Helldiver Lake was first stocked in 1949 with Cutthroat Trout, and has been stocked intermittently with Cutthroat Trout ever since. It is currently stocked with ~550 WCT, once every three years. Helldiver Lake receives a relatively high level of angler visitation due to access via a short (2.4 km) maintained trail (Table 4). The last two times Helldiver Lake was surveyed (1966 and 2001) it was suspected that high rates of natural reproduction contributed to an overabundant population of small WCT. In 2017, we surveyed Helldiver Lake on August 18.

Helldiver Lake – We captured 34 WCT during 17.8 h of gill netting (CPUE = 1.91 fish/h) in 2017 (Table 3). WCT ranged in length from 92 to 336 mm TL, and averaged 198 mm (± 10.3, *n* = 34; Table 3, Figure 5), with relative weights varying widely (mean W_r 94.0, range, 72.4–122.3; Figure 5). Length-at-age data shows strong evidence that WCT are naturally reproducing in this lake, and similar to previous years, the WCT population in Helldiver Lake currently seems to be overabundant and relatively small in size (Figure 6). Although this is a “high-use” area that should be maintained for high catch rates, further stocking is likely not necessary to maintain high catch rates. Therefore, we recommend discontinuing stocking to determine whether natural reproduction is sufficient to maintain the fishery (Table 6). No amphibians were observed in 2017 (Table 3).

Lost Lake – Lost Lake was first stocked with Cutthroat Trout in 1966 and has been intermittently stocked with Cutthroat Trout ever since. It is currently stocked with approximately 200 WCT on a 3-year rotation. In previous surveys (1966 and 2001) fish in this lake were relatively small (<250 mm). There is good trail access to Lost Lake (~3.2 km) from Josephus Lake, but surveyors in 2017 estimated angler use as low (Table 4). We surveyed Lost Lake on August 17, 2017.

Lost Lake – We captured 23 WCT during 14.5 h of gill netting (CPUE = 1.59 fish/h) in 2017 (Table 3). WCT caught in the gill net ranged in length from 224 to 332 mm TL, and averaged 278 mm (± 5.0, *n* = 23), and relative weights were generally below average (mean W_r = 81.4, range, 63.2–97.4; Table 3, Figure 5). Based on ageing data, all of the fish we caught in 2017 may have been from a single stocking event in 2012. We estimated ages at age-5 and age-6 (Figure 6), but it is possible that we misread otolith annuli and all fish are age-5. The survey crew in 2017 also noted a large number of smaller fish in the outlet of Lost Lake, which may have been fish stocked in 2015. Although several assumptions are being made here, it is possible that this fishery may be solely maintained via stocking. We recommend continuing with current stocking regime (Table 6). No amphibians were observed in 2017.

Soldier Creek Drainage

<u>Muskeg Lakes</u> – There are three larger lakes in the Muskeg Lakes Basin (Muskeg Lakes #1 and #3 and Cutthroat Lake) and several smaller ponds. Our records show that stocking began in these lakes in 1949, and by 1981 Muskeg Lakes #1, #2, and #3, and Cutthroat Lake had all been stocked several times each with Cutthroat Trout. In 1988 stocking was deemed unnecessary and halted in Cutthroat Lake, due to natural reproduction taking place, and was halted in Muskeg #2 due to insufficient lake depth. Around that same time, we switched to stocking Rainbow Trout in Muskeg Lakes #1 and #3. During the last survey at these lakes (2001) Cutthroat Lake was still holding naturally reproducing Cutthroat Trout, and Muskeg Lake #1 supported both Cutthroat and Rainbow Trout. Muskeg Lakes #2 and #3 were fishless in 2001. Currently, Muskeg Lakes #1 and #3 are stocked with ~500 RBT each on a 3-year rotation. Due to their remoteness (approximately 9.6 km from Josephus TH) these lakes likely see a relatively low amount of angler effort (Table 4). Muskeg Lakes #1, #2, and #3 were surveyed August 20 – 21, 2017.

Muskeg Lake #1 – One gill net was set in Muskeg Lake #1 for 16.8 h and caught 11 RBT and one WCT (combined CPUE = 0.72 fish/h; Table 3). Total length of RBT ranged from 225 to 370 mm, with an average of 337 mm (± 12.7, n = 11), and the WCT measured 334 mm TL (Table 3, Figure 7). RBT relative weights averaged 79.4 (range, 67.9–90.3) and relative weight on the WCT was 94.8 (Figure 7). WCT have not been stocked in this basin since 1988, but likely there is a naturally reproducing population established (both in Cutthroat Lake and in Muskeg Creek) that has the ability to colonize these lakes occasionally. In general, fish in this lake are relatively low in abundance but can grow quite large. It does not seem like this lake would support much of a fishery without the aid of stocking, so stocking should continue (Table 6). No amphibians were observed in 2017 (Table 3).

Muskeg Lake #2 – This lake was not surveyed with gill nets or angling in 2017, but we walked around it and did not observe any fish or amphibians (Table 5). Based on this and previous surveys, the lake should not be stocked in the future.

Muskeg Lake #3 – One gill net was set in Muskeg Lake #3 for 12.3 h and caught three RBT (CPUE = 0.24 fish/h; Table 3). All three RBT we caught were age-6 (Figure 8) and total lengths ranged 260 to 266 mm (Table 3, Figure 7). Relative weights averaged 88.2 (range, 86.9–89.7; Figure 7). Similar to Muskeg Lake #1, this fishery likely requires continued stocking to sustain it. It does not appear that natural reproduction is occurring in this lake, and we did not see any trout from the group that was stocked in 2015 in our gill net. We recommend to continue stocking at the current frequency at this time (Table 6). No amphibians were observed in 2017 (Table 3).

<u>Soldier Lakes</u> – There are 10 lakes and several smaller ponds within the Soldier Lakes Basin. Nine of the lakes (Soldier Creek Lakes #2, #4, #5, #6, #7, #8, #9, #10, and #11) have been stocked over the years, beginning in 1949 with Cutthroat Trout. Currently Soldier Lakes #4, #7, #8, #10, and #11 are stocked on a 3-year rotation with WCT (~975, 250, 250, 250, and 250, respectively). Soldier Lakes #1, #2, and #5 were classified as supporting naturally reproducing populations of trout when they were surveyed in 2001, and are no longer stocked. In 2017, we estimated that these lakes receive a rare to moderate level of angler-use (Table 4). Access to these lakes is ~4.8 km from the Josephus TH. We surveyed Soldier Lakes #1, #2, #3, #3A, #4, #5, #6, #7, #8, #9, and #11 between August 19 and August 21, 2017.

Soldier Lake #1– This lake was not surveyed with gill nets or angling in 2017, but we walked around it and observed a few very large adult fish surfacing (Table 3). The lake appeared that it may be deep enough to support fish overwinter, but fish have never been stocked here, so they must colonize the lake from the outlet stream (Soldier Creek). We recommend adding this lake to the stocking rotation, at a low density to improve catch rates (Table 6). This lake was not surveyed for amphibians in 2017 (Table 3).

Soldier Lake #2 – This lake was not surveyed with gill nets or angling in 2017, but we walked around it and did observe fry in the inlet and adult fish surfacing (Table 3). In 2001, surveyors found WCT in very low abundance. However, in 1956 and 1966 surveyors noted abundant natural reproduction. We recommend adding this lake to the stocking rotation at a low density (Table 6) to maintain higher catch rates in the fishery. No amphibians were observed in 2017 (Table 3).

Soldier Lake #3 and #3A – These lakes were not surveyed with gill nets or angling in 2017, but we walked around them and did not observe any fish (Table 5). Both lakes appear to be too shallow to support fish over winter, so should not be added to the stocking rotation. Long-toed salamanders were observed at both lakes in 2017 (Table 5).

Soldier Lake #4 – One gill net was set in Soldier Lake #4 for 16.3 h and caught 27 WCT (CPUE = 1.66 fish/h; Table 3). Additionally, one WCT was caught in less than one hour of angling (CPUE = 1.20 fish/h; Table 3). Total length of gill netted WCT ranged from 81 to 310 mm, with an average of 210 mm (± 11.0, n = 27; Table 3, Figure 7) and relative weights averaged 74.2 (range, 56.8–94.1; Figure 7). All year classes of WCT from age-2 to age-9 were represented in our sample (Figure 8), suggesting natural reproduction is occurring in this lake. As such, abundance appears to be relatively high and growth rate is relatively slow (Figure 8). Soldier Lake #4 is the largest of the Soldier Lakes and due to its proximity to the trail and trailhead, likely sees the most angler effort. Soldier Lake #4 should therefore be maintained with high catch rates. However, natural reproduction may be sufficient for maintaining the fishery, so stocking could potentially be halted without negatively impacting this fishery. We recommend removing from the stocking rotation (Table 6). It will be important to reassess this lake after stocking is halted to ensure catch rates remain high. No amphibians were observed in 2017 (Table 3).

Soldier Lake #5 – We did not gill net Soldier Lake #5 in 2017, but fished the lake for 7.0 h and caught seven WCT (CPUE = 1.00 fish/h; Table 3). Although WCT were not measured, we estimated lengths of caught fish ranged 150 to 300 mm TL. This lake has not been stocked since 1997, so this fish population is currently self-sustaining. Therefore, we recommend leaving this lake off the stocking rotation and allowing natural reproduction to sustain the fishery. No amphibians were observed in 2017 (Table 3).

Soldier Lake #6 – This lake was not surveyed with gill nets or angling in 2017, but we walked around it and did not observe any fish (Table 5). The lake appears to be too shallow to support overwintering fish. It is not stocked and should not be added to the stocking rotation. Long-toed salamanders were observed in 2017 (Table 5).

Soldier Lake #7 – One gill net was set in Soldier Lake #7 for 15.2 h and caught 46 WCT (CPUE = 3.03 fish/h; Table 3). Additionally, nine WCT were caught in 6.0 h of angling (CPUE = 1.50 fish/h; Table 3). Total length of gill-netted WCT ranged from 87 to 270 mm, with an average of 158 mm (± 7.4, *n* = 46; Table 3, Figure 7) and relative weights averaged 92.4 (range, 75.1–121.9; Figure 7). All year classes of WCT from age-2 to age-6 were represented in our sample (Figure 8), suggesting natural reproduction is occurring in this lake. As a result, similar to Soldier Lake #4, abundance appears to be relatively high and growth rate is relatively slow (Figure 8). Also similar to Soldier Lake #4, this lake is in close proximity to the trail and trailhead, and likely sees more angler effort than several of the other lakes in the basin. This lake should therefore continue to be maintained with high catch rates. However, natural reproduction may be sufficient for maintaining the fishery, so stocking could likely be halted without negatively impacting this fishery (Table 6). We recommend to discontinue stocking and reassess catch rates and size distribution after several years to evaluate fish size and catch rates. No amphibians were observed in 2017 (Table 3).

Soldier Lake #8 – One gill net was set in Soldier Lake #8 for 15.5 h and caught 20 WCT (CPUE = 1.29 fish/h; Table 3). Total length of gill netted WCT ranged from 95 mm to 391 mm, with an average of 220 mm (± 23.5, *n* = 20; Table 3, Figure 7) and relative weights averaged 89.0 (range, 73.8–103.4; Figure 7). All year classes of WCT from age-2 to age-7 were represented in our sample (Figure 8), suggesting natural reproduction is occurring in this lake. Although abundance is relatively lower in this lake than in Soldier Lake #4 and #7, this lake also may benefit from halting stocking to improve growth rates (Table 6). Again, it will be important to reassess this lake after stocking is halted to ensure catch rates remain high. No amphibians were observed in 2017 (Table 3).

Soldier Lake #9 – One gill net was set in Soldier Lake #9 for 14.8 h and caught 46 WCT (CPUE = 3.12 fish/h; Table 3). Additionally, four WCT were caught during 1.2 h of combined angling (CPUE = 3.42 fish/h; Table 3). Total length of gill netted WCT ranged from 84 mm to 279 mm, with an average of 147 mm (± 8.4, *n* = 46; Table 3, Figure 7). Relative weights averaged 86.0 (range, 60.9–116.5) and generally decreased with an increase in TL (Figure 7). All year classes of WCT from age-2 to age-6 were represented in our sample (Figure 8), suggesting natural reproduction is occurring in this lake. Similar to many of the other Soldier Lakes, abundance is relatively high and fish size is generally small, so this lake may benefit from halting stocking to improve growth rates (Table 6). It will be important to reassess this lake after stocking is halted to ensure catch rates remain high. No amphibians were observed in 2017 (Table 3).

Soldier Lake #11 – One gill net was set in Soldier Lake #11 for 17.3 h and caught 31 WCT (CPUE = 1.79 fish/h; Table 3). Additionally, 12 WCT were caught during 5.8 h of combined angling (CPUE = 2.09 fish/h; Table 3). Total length of gill netted

WCT ranged from 83 mm to 304 mm, with an average of 165 mm (± 12.7, n = 31; Table 3, Figure 7), and relative weights averaged 98.8 (range, 84.1–111.4; Figure 7). All year classes of WCT from age-2 to age-7 were represented in our sample (Figure 8), suggesting natural reproduction is occurring in this lake. Similar to many of the other Soldier Lakes, abundance is relatively high in Soldier Lake #11 and fish are small. However, fish condition (relative weight) was generally higher in this lake than in the other Soldier Lakes. This lake would also likely benefit from halting stocking to improve growth rates (Table 6). As with the others previously mentioned, it will be important to reassess this lake after stocking is halted to ensure catch rates remain high. Columbia Spotted Frogs were observed in 2017 (Table 3).

Kidney Lakes

Kidney Lakes – There are four lentic waterbodies within the Kidney Lakes Basin, only one of which is currently stocked (Kidney Lake #2). Kidney Lakes #1 and #2 are the only lakes in this basin that have ever been stocked, dating back to 1939. However, surveys in 2010 suggested stocked fish were not surviving in Kidney Lake #1, so it was removed from the stocking plan. Currently, Kidney Lake #2 is the only lake stocked in this series, with approximately 150 WCT on a 3-year rotation. Access to these lakes is cross-country, but short (~0.8 km). Surveyors in 2017 estimated angler use as moderate at Kidney Lake #2 (Table 4). We surveyed Kidney Lakes #1, #2, and #3 on July 23, 2017.

Kidney Lake #1 – This lake was not surveyed with gill nets in 2017, but we walked around it and fished it for 1.0 h and saw no evidence of fish in the lake (Table 5). The lake appears to be very shallow and supports an abundance of amphibians. In 2017, we observed both Columbia Spotted Frogs and Long-Toed Salamanders (Table 5). We recommend no changes to this lake.

Kidney Lake #2 – We set one gill net for 13.5 h and did not catch any fish in this lake (Table 5). Surveyors noted that no fish were seen surfacing on the lake, and it did not appear that any fish were present. This is the deepest lake of the three Kidney Lakes (max depth = 3.6 m; Table 4), and likely the only one that would support fish over winter. In 1988, we found a ~600 mm RBT in this lake, so fish can certainly survive in some years and can reach exceptional size. However, this lake is among several that we surveyed this year and did not find fish even though they were stocked in 2015. It is likely several of these lakes experienced winterkill in 2017/2018. We recommend continuing to stock this lake and re-evaluate in the future (Table 6). We observed Columbia Spotted Frogs at this lake in 2017 (Table 5).

Kidney Lake #3 – This lake was not surveyed with gill nets or angling in 2017, but we walked around it and we do not believe there are any fish in the lake (Table 5). The lake appears to be very shallow and supports an abundance of amphibians. In 2017, we observed numerous Columbia Spotted Frogs (Table 5). We do not recommend any fish stocking at this time.

Iris Lakes

<u>Iris Lakes</u> – There are four lentic waterbodies within the Iris Lakes Basin, two of which are currently stocked (Iris Lakes #1 and #3). Stocking began in this series in 1966. Iris Lake #2 was stocked in 1969 and 1972 with Cutthroat Trout, and has not been stocked since then, but does support fish persistence. Iris Lake #3 was stocked with Golden Trout in 1978 and 1981, and with Rainbow Trout from 1982 to 1995, but has only been stocked with Cutthroat Trout since then. Currently, Iris Lakes #1 and #3 are currently stocked with approximately 220 and 340 WCT, respectively, on a three year rotation. When these lakes were surveyed in 2017, the crew estimated angler use as rare to low, as access requires approximately 5.6 km of hiking on trail followed by 1.6 km of cross country hiking (Table 4). We surveyed Iris Lakes #1, #2, and #3 on August 22, 2017.

Iris Lake #1 – We set one gill net for 17.8 h and did not catch any fish in this lake (Table 5). Surveyors noted that the lake surface was approximately 3.5 m below high water mark, and maximum lake depth was estimated at 3.7 m. This lake may not support fish persistence over winter at this time and should be removed from the stocking rotation until further notice (Table 6). Long-Toed Salamander larvae were very abundant when the lake was surveyed in 2017 (Table 5).

Iris Lake #2 – This lake was not surveyed with gill nets in 2017, but we walked around it and fished it for 4.0 h and caught 12 RBT x WCT hybrids (CPUE = 3.0 fish/h; Table 3). Similar to Iris Lake #1, the lake surface was well below the high water mark in this lake, but large red copepods were abundant and fish were utilizing them. The fish we caught in this lake were not measured, but were estimated to be between 350 and 450 mm TL. This lake provides quality fishing opportunity without currently being stocked, so we recommend leaving the lake as-is. No amphibians were documented in 2017 (Table 3).

Iris Lake #3 – One gill net was set in Iris Lake #3 for 13.7 h and caught 10 WCT, eight RBT, and one RBT x WCT hybrid (combined CPUE = 1.39 fish/h; Table 3). Additionally, three WCT and one RBT x WCT were caught during 1.5 h of combined angling (CPUE = 2.67 fish/h; Table 3). Total length of gill netted WCT ranged from 101 to 385 mm, with an average of 203 mm (± 33.8, n = 10), RBT total length ranged 86 to 405 mm [average = 231 mm (± 33.7, n = 8)], and the RBT x WCT hybrid measured 316 mm TL (Table 3, Figure 9). Relative weights averaged 96.7 (range, 81.7–108.0) for WCT, 92.6 (range, 65.1–111.3) for RBT, and was 90.8 for the RBT x WCT (Figure 9). All year classes of WCT from age-2 to age-5 were represented in our sample (Figure 10), and the presence of RBT and RBT x WCT hybrids (which are not stocked) suggests natural reproduction is occurring in this lake. Fishing pressure at this lake is likely low (Table 3), so the current diversity of species and quality size represented in this lake seem appropriate. We recommend continuing to stock this lake at the current density (Table 6). No amphibians were observed in 2017 (Table 3).

Cliff Creek Lakes

<u>Cliff Creek Lakes</u> – There are five lentic waterbodies within the Cliff Creek Lakes Basin, only two of which have ever been stocked (Cliff Creek Lakes #1 and #4). Stocking began in Cliff Creek Lakes #1 and #4 in 1966 with Cutthroat Trout, which are the only species that have been stocked since then. Currently, both lakes are stocked on a 3-year rotation with approximately 140 and 70 WCT, respectively. During the last survey, in 2007, fish were only found in Cliff Creek Lake #1. In 2017, we estimated human-use as rare at these lakes (Table 4). We surveyed Cliff Creek Lakes #1, #2, #3, and #5 between July 22 and 23, 2017.

Cliff Creek Lake #1 – One gill net was set in Cliff Creek Lake #1 for 16.8 h and caught 20 WCT (CPUE = 1.19 fish/h; Table 3). No fish were caught during 0.5 h of angling (CPUE = 0.0 fish/h; Table 3). Total length of gill netted WCT ranged from 101 to 246 mm, with an average of 167 mm (± 10.2, n = 20; Table 3, Figure 11) and relative weights averaged 101.6 (range, 83.5–125.1; Figure 11). Only two year classes of WCT were represented in our sample (age-3 to age-4; Figure 12). Although this suggests natural reproduction is occurring in the lake, it is likely occurring at a low rate. We observed several redds in the lake in 2017, as well as fry and fingerlings. However, the lack of older age fish suggests some inability of fish to persist long-term. This lake may require stocking to ensure fish persistence (Table 6). Columbia Spotted Frogs were observed in 2017 (Table 3).

Cliff Creek Lake #2 – This lake was not surveyed with gill nets in 2017, but we walked around it and fished it for 0.5 h and we do not believe there are any fish in the lake (Table 5). The lake appeared to be deep enough in some spots to support fish persistence (~3 to 4m), but we do not recommend adding it to the stocking rotation at this time because satellite imagery suggests in most years this "lake" is more of a wetland. We did not observe any amphibians in 2017 (Table 5). We do not recommend adding this lake to the stocking rotation.

Cliff Creek Lake #3 – This lake was not surveyed with gill nets in 2017, but we walked around it and fished the lake for 0.5 h. Although we didn't catch any fish, we observed a few fish surfacing (Table 3). The lake appeared too shallow to support fish overwinter, and was very productive for amphibians. We observed an abundance of Columbia Spotted Frogs in 2017 (Table 3). We do not recommend stocking any fish at this time.

Cliff Creek Lake #5 – We set one gill net for 13.5 h and did not catch any fish in this lake (Table 5). Surveyors noted that this lake is small and shallow and does not see much human use (Table 4), and would likely not support fish persistence over winter (Table 5). Therefore, not stocking is recommended at this time. We observed Columbia Spotted Frogs at this lake in 2017 (Table 5).

Iron Creek Lakes

Iron Creek Lakes – There are three lakes in the Iron Creek Lakes Basin, only two of which have ever been stocked (Iron Creek Lakes #6 and #7). Stocking began in Iron Creek Lakes #6 and #7 in 1970 with Cutthroat Trout. Iron Creek Lake #7 was switched to Rainbow Trout stocking in 1982, and Iron Creek Lake #6 was switched to Rainbow Trout stocking in 2000. Currently, both lakes are stocked on a 3-year rotation with approximately 75 RBT, each. During the last survey, in 1988, WCT were found in both lakes, with some level of natural reproduction suspected in both. In 2017, we estimated human-use as rare at these lakes (Table 4). We surveyed Iron Creek Lakes #6 and #7 on August 6, 2017.

Iron Creek Lake #6 - One gill net was set in Iron Creek Lake #6 for 13.0 h and caught nine WCT (CPUE = 0.69 fish/h; Table 3). Additionally, 10 WCT and one RBT were caught during 7.0 h of combined angling (CPUE = 1.43 fish/h; Table 3). Total length of gill netted WCT ranged from 266 to 362 mm, with an average of 314 mm (± 9.6, n = 9; Table 3, Figure 13). Relative weights averaged 103.6 (range, 92.1–123.5; Figure 13), and all fish were estimated to be age-5 (Figure 14). The presence of only one year class of WCT suggests natural reproduction may not be successful every year. However, WCT have not been stocked in the lake since 1997, so some level of natural reproduction is certainly occurring. RBT were in very low abundance relative to WCT, so stocking RBT does not seem to be benefitting this fishery. We recommend switching this lake from RBT stocking to WCT stocking, and increasing stocking density to help maintain the current WCT population (Table 6). No amphibians were observed in 2017.

Iron Creek Lake #7 - One gill net was set in Iron Creek Lake #7 for 14.0 h and caught two WCT (CPUE = 0.14 fish/h; Table 3). Total length of gill netted WCT was 144 and 275 mm (Table 3, Figure 13). Relative weights were 115.6 and 85.4, respectively (Figure 13), and ages were estimated to be age-4 and age-7, respectively (Figure 14). Again, the presence of only two year classes of WCT suggests natural reproduction may not be successful every year, but it is certainly occurring, as WCT have not been stocked in the lake since 1979. Stocking RBT does not seem to be benefitting this fishery. Recommend switching this lake from RBT stocking to WCT stocking, at a higher density, to assist with maintenance of the current WCT population (Table 6). No amphibians were observed in 2017.

MANAGEMENT RECOMMENDATIONS

1. Review and implement annual changes in stocking recommendations for each lake.

2. Use information gathered in these surveys to construct a high mountain lake angling guide for public use.

3. Develop a plan to reassess lakes where management changes have been made.

Table 1. Salmon Region high mountain lake stocking rotations A, B, and C by year, 2016 through 2022.

	Stocking rotation sequence		
	A	B	C
Year	2023	2024	2016
of	2017	2018	2019
stocking	2020	2021	2022

Table 2. High Mountain Lakes stocked in the Salmon Region in 2017 (Rotation A). Species stocked include Rainbow Trout (RBT), Grayling (GRA), Golden Trout (GNT), and Westslope Cutthroat Trout (WCT).

Date stocked	Lake name	IDFG cat. num	Species	Number stocked
8/30	Pole	07-0834	RBT	176
8/30	Liberty #1	07-0830	RBT	146
8/30	Liberty #2	07-0833	RBT	198
8/30	Rock #1	07-0863	RBT	124
8/30	Rock #2	07-0864	RBT	549
8/30	Twin C. #2	07-1319	RBT	124
8/30	China #3	07-0885	GNT	601
8/31	Cache C. #3	07-0845	GRA	724
8/31	Cache C. #5	07-0848	GRA	724
8/31	Nelson #2	07-0873	GRA	724
8/25	Tin Cup	07-1349	GRA	802
8/25	Feldspar	07-1380	GRA	802
8/25	Hope	07-1430	GRA	802
8/25	MacRae (Upper Deer)	07-1450	GRA	1003
8/31	Martindale #1	07-0815	GRA	725
8/31	Knapp #14	07-1179	GRA	724
8/31	Vanity #13	07-1027	GRA	724
8/31	Seafoam #6	07-1005	GRA	724
8/31	Rainbow	07-1153	GRA	724
8/31	Upper Redfish #1	07-1634	GRA	724
8/25	Falconberry	07-0860	WCT	496
8/25	Horseshoe	07-0910	WCT	865
9/1	Pipe	07-1732	WCT	205
9/1	Lightning	07-1680	WCT	273
9/1	Six #1	07-1672	WCT	806
9/1	Thunder	07-1679	WCT	219
9/1	Phyllis	07-1683	WCT	369
9/1	Washington #1	07-1443	WCT	301
9/1	Castleview	07-1440	WCT	246
9/1	Chamberlain #7	07-1439	WCT	875
9/1	Fourth of July	07-1685	WCT	724
9/1	Castle	07-1420	WCT	1011
9/1	Drift	07-1424	WCT	369
9/1	Scoop	07-1403	WCT	451
9/1	Headwall	07-1405	WCT	396
9/1	Big Frog #2	07-1385	WCT	997

Table 2 (continued)

Date stocked	Lake name	IDFG cat.num	Species	Number stocked
9/1	Little Redfish	07-1347	WCT	246
9/1	Sheep	07-1356	WCT	505
9/1	Slide	07-1363	WCT	273
9/1	Ocalkens #1	07-1464	WCT	505
9/1	Crater	07-1460	WCT	874
9/1	Swimm	07-1467	WCT	874
9/1	Garland #1	07-1468	WCT	505
9/1	Garland #2	07-1469	WCT	505
9/1	East Basin C. #1	07-1514	WCT	478
9/1	Mystery #3	07-0879	WCT	68
8/30	Hoodoo	07-1463	WCT	250
8/31	Castle #1	07-0835	WCT	123
8/31	Castle #2	07-0837	WCT	246
8/31	Martindale #2	07-0816	WCT	205
8/31	WF Camas C. #1	07-0818	WCT	1202
8/31	WF Camas C. #3	07-0820	WCT	751
8/31	WF Camas C. #5	07-0824	WCT	505
8/31	Cache C. #1	07-0843	WCT	997
8/31	Challis C. #2	07-1333	WCT	369
8/31	Cirque	07-1369	WCT	1147
8/31	Sapphire	07-1367	WCT	1257
8/31	Cove	07-1364	WCT	1106
8/31	Goat	07-1375	WCT	1147
9/12	Hindman #1	07-1495	WCT	511

Table 3. Fish presence and catch rate in high mountain lakes surveyed in 2017, where fish were found (*n* = 42) including current stocking information, fish species, mean total length (TL), and whether or not amphibians were observed.

Drainage/ lake name	Species stocked	Stocking density (fish/ha)	Fish species present	# caught	CPUE (fish/h) angling/gill netting	Mean TL (range, mm)	Amphibians present[a]
Alpine Creek Lakes							
Alpine Creek Lake #4	GRA	28.9	WCT	17	--/1.21	276 (154-400)	none
Alpine Creek Lake #4A	none	--	Unknown	--	visual only	--	not surveyed
Alpine Creek Lake #4B	none	--	Unknown	--	visual only	--	not surveyed
Alpine Creek Lake #5	RBT	115.5	RBTxWCT	2	--/0.11	457 (449-465)	none
Alpine Creek Lake #6	WCT	115.8	WCT	13	--/0.95	247 (161-378)	none
Alpine Creek Lake #7	WCT	126.3	WCT	14	--/0.86	308 (225-358)	none
Alpine Creek Lake #11	RBT	130.3	RBT	6	--/0.34	296 (180-339)	none
			GRA	2	--/0.11	354 (333-374)	
			GNT	3	--/0.17	298 (251-335)	
Alpine Creek Lake #12	WCT	1275.0	WCT	2	--/0.30	283 (281-284)	none
Alpine Creek Lake #12A	none	--	Unknown	--	visual only	--	not surveyed
Alpine Creek Lake #13	GRA	73.7	GRA	34	--/2.19	338 (197-382)	none
			WCT	1	--/0.06	422	
Alpine Creek Lake #14	GRA	50.3	GRA	21	--/1.60	248 (108-356)	none
			WCT	4	--/0.30	211 (100-315)	
Alpine Creek Lake #15	GRA	75.1	Unknown	0	--/0.00	visual observ.	none
Vanity Summit Area							
Baldwin Creek Lake	WCT	121.7	WCT	8	0.50/0.45	274 (124-381)	none
			RBT	4	0.50/0.15	358 (348-368)	
Langer Lake #1	RBT	209.2	WCT	13	0.00/0.81	312 (89-420)	WT
Lower Island Lake	WCT	258.1	RBT	45	--/3.27	149 (72-462)	none
			WCT	10	--/0.73	128 (82-340)	
Rocky Lake	WCT	118.4	WCT	0	0.00/--	405 mm mort.	LTS
Ruffneck Lake	RBT	195.2	RBT	30	0.67/2.29	192 (70-470)	none
Vanity Lake #1	RBT	132.2	WCT	29	4.00/1.90	199 (105-286)	none
			RBT	2	0.00/0.14	325 (230-420)	
Vanity Lake #3	none	--	Unknown	--	visual only	--	CSF
Vanity Lake #4	RBT	120.5	RBT	7	0.20/0.32	302 (117-443)	none
			RBTxWCT	3	0.20/0.11	307 (304-310)	
Vanity Lake #6	none	--	WCT	12	4.00/--	no lengths taken	CSF
			RBT	1	0.34/--	no lengths taken	
Vanity Lake #7	RBT	135.3	WCT	1	--/0.06	266	WT

Table 3 (continued)

Drainage/ lake name	Species stocked	Stocking density (fish/ha)	Fish species present	# caught	CPUE (fish/h) Angling/Gill netting	Mean TL (range) (mm)	Amphibians present[a]
Float Creek Drainage							
Harlan Creek Lake #1	WCT	250.8	WCT	19	--/1.52	306 (192-388)	none
Hasbrook Lake #1	WCT	123.7	WCT	35	--/2.69	237 (96-312)	none
Helldiver Lake	WCT	123.2	WCT	34	--/1.91	198 (92-336)	none
Lost Lake	WCT	38.7	WCT	23	--/1.59	278 (224-332)	none
Soldier Creek Drainage							
Muskeg Lake #1	RBT	292.4	RBT	11	--/0.66	337 (225-370)	none
			WCT	1	--/0.06	334	
Muskeg Lake #3	RBT	216.1	RBT	3	--/0.24	263 (260-266)	none
Soldier Lake #1	none	--	WCT	--	visual only	--	not surveyed
Soldier Lake #2	none	--	Unknown	--	visual only	--	none
Soldier Lake #4	WCT	389.6	WCT	28	1.20/1.66	210 (81-310)	none
Soldier Lake #5	none	--	WCT	7	1.00/--	no lengths taken	none
Soldier Lake #7	WCT	200.8	WCT	55	1.50/3.03	158 (87-270)	none
Soldier Lake #8	WCT	84.1	WCT	20	--/1.29	220 (95-391)	none
Soldier Lake #9	WCT	221.8	WCT	50	3.43/3.12	147 (84-279)	none
Soldier Lake #11	WCT	271.1	WCT	43	2.09/1.79	165 (83-304)	CSF
Iris Lakes							
Iris Lake #2	none	--	RBTxWCT	12	3.00/--	no lengths taken	none
Iris Lake #3	WCT	121.8	WCT	13	2.00/0.73	203 (101-385)	none
			RBT	8	0.00/0.59	231 (86-405)	
			RBTxWCT	2	0.67/0.07	316	
Cliff Creek Lakes							
Cliff Creek Lake #1	WCT	117.5	WCT	20	0.00/1.19	167 (101-246)	CSF
Cliff Creek Lake #3	none	--	Unknown	--	visual only	--	CSF
Iron Creek Lakes							
Iron Creek Lake #6	RBT	58.5	WCT	18	1.29/0.69	314 (266-362)	none
			RBT	1	0.14/0.00	no lengths taken	
Iron Creek Lake #7	RBT	58.5	WCT	2	--/0.14	210 (144-275)	none

[a] CSF = Columbia Spotted Frog, LTS = Long-toed Salamander, WT = Western Toad

Table 4. High mountain lakes surveyed in 2017 (n = 57), including lake number (LLID), elevation, surface area (ha), secchi depth (m), estimated maximum depth (m), train and cross-country (XC) hiking distance, number of campsites, and estimated level of use.

Drainage/ lake name	LLID [a]	Elevation (m)	Area (ha)	Secchi depth (m)	Max depth (m)	Trail distance (km)	XC distance (km)	# campsites	Human use
Alpine Creek Lakes									
Alpine Creek Lake #2	1149735438870	2434	1.2	3.4	3.4	5.6	3.2	1	Rare
Alpine Creek Lake #4	1149726439072	2598	12.7	7.0	15.2	5.6	0.8	5	Moderate
Alpine Creek Lake #4A	1149772439084	2604	0.5	--	--	5.6	1.6	0	Rare
Alpine Creek Lake #4B	1149798439069	2619	0.4	--	--	5.6	1.6	0	Rare
Alpine Creek Lake #5	1149815439052	2568	1.1	6.5	>10	5.6	1.6	0	Rare
Alpine Creek Lake #6	1149828439107	2639	2.6	6.5	7.1	5.6	2.4	1	Low
Alpine Creek Lake #7	1149925439093	2824	2.7	5.5	7.3	5.6	4.0	0	Rare
Alpine Creek Lake #11	1149701439146	2738	3.3	10.0	29.6	5.6	3.2	0	Low
Alpine Creek Lake #12	1149699439196	2655	0.4	3.5	3.5	5.6	3.2	1	Low
Alpine Creek Lake #12A	1149717439208	2648	0.4	--	--	5.6	3.2	0	Rare
Alpine Creek Lake #13	1149734439270	2759	6.7	6.5	17.5	5.6	3.2	0	Rare
Alpine Creek Lake #14	1149599439213	2599	3.2	4.5	10.1	4.8	2.4	2	Moderate
Alpine Creek Lake ##15	1149715439307	2795	4.9	7.5	12.2	5.6	3.2	0	Low
Vanity Summit Area									
Baldwin Creek Lake	1151123444950	2532	2.9	6.6	6.6	0.0	6.4	0	Rare
Bear Creek Lake #1	1150941444859	2422	1.3	4.0	4.0	0.0	0.0	1	High
Island Lake	1151473444730	2517	5.0	--	14.2	3.2	0.3	1	Moderate
Langer Lake #1	1151347444803	2449	4.8	7.5	8.3	3.2	0.0	3	High
Lower Island Lake	1151366444722	2438	2.1	5.7	5.7	4.0	0.3	1	Moderate
Rocky Lake	1151353444863	2507	3.8	--	5.5	3.2	0.8	2	Moderate
Ruffneck Lake	1151425444755	2445	6.4	4.5	11.6	3.2	0.0	6	High
Vanity Lake #1	1150528444936	2400	2.3	5.6	5.6	0.0	3.2	2	Moderate
Vanity Lake #3	1150565444907	2424	2.2	--	--	0.0	3.2	0	Low
Vanity Lake #4	1150493444883	2507	2.1	--	--	0.0	4.0	0	Rare
Vanity Lake #5	1150560444885	2426	1.0	5.1	5.1	0.0	4.8	1	Low
Vanity Lake #6	1150628444880	2436	1.3	--	--	0.0	3.2	0	Low
Vanity Lake #7	1150648444848	2457	1.5	3.0	3.0	0.0	3.2	0	Rare
Float Creek Drainage									
Harlan Creek Lake #1	1151400445303	2412	1.2	3.0	3.6	0.0	1.6	1	Low
Harlan Creek Lake #2	1151481445220	2569	1.0	6.4	6.4	0.0	3.2	0	Low

Table 4 (continued)

Drainage/ lake name	LLID [a]	Elevation (m)	Area (ha)	Secchi depth (m)	Max depth (m)	Trail distance (km)	XC distance (km)	# campsites	Human use
Hasbrook Lake #1	1151786445219	2545	3.0	2.7	2.7	0.0	1.6	1	Low
Helldiver Lake	1151724445350	2350	4.4	4.5	5.2	2.4	0.0	2	High
Lost Lake	1151596445294	2444	5.2	5.0	12.4	2.9	0.3	1	Low
Soldier Creek Drainage									
Muskeg Lake #1	1152100445438	2360	1.7	4.1	4.1	9.7	0.0	1	Low
Muskeg Lake #2	1152062445428	2422	0.4	2.1	2.1	9.7	0.3	0	Rare
Muskeg Lake #3	1152187445407	2445	2.3	4.8	4.8	9.7	1.3	0	Low
Soldier Lake #1	1152013445363	2399	0.9	--	--	6.0	0.0	1	Low
Soldier Lake #2	1152034445388	2424	1.6	--	--	6.0	0.0	0	Moderate
Soldier Lake #3	1151909445274	2484	0.6	2.1	2.1	5.6	0.5	0	Low
Soldier Lake #3A	1151921445270	2483	0.5	0.5	0.5	5.6	0.5	0	Rare
Soldier Lake #4	1151941445301	2384	2.5	5.5	13.9	4.8	0.0	2	Low
Soldier Lake #5	1151958445254	2472	2.1	--	--	5.6	0.8	0	Low
Soldier Lake #6	1151920445240	2545	0.4	--	6.1	4.8	1.6	0	Rare
Soldier Lake #7	1151989445294	2410	1.2	3.7	3.7	5.6	0.0	2	Moderate
Soldier Lake #8	1152017445263	2432	2.9	5.5	14.5	5.6	0.8	1	Moderate
Soldier Lake #9	1152020445293	2421	1.1	6.0	6.0	5.6	0.0	1	Low
Soldier Lake #11	1152032445309	2434	0.9	6.2	6.2	5.6	0.0	0	Low
Kidney Lakes									
Kidney Lake #1	1149732445262	2448	0.4	--	--	0.0	0.8	0	Low
Kidney Lake #2	1149724445226	2486	1.2	3.6	3.6	0.0	0.8	2	Moderate
Kidney Lake #3	1149729445197	2557	0.9	--	--	0.0	0.5	0	Low
Iris Lakes									
Iris Lake #1	1151940445113	2436	1.9	3.7	3.7	5.6	1.6	0	Low
Iris Lake #2	1151981445146	2468	0.8	--	--	5.6	1.6	0	Rare
Iris Lake #3	1152023445170	2518	2.8	8.0	12.4	5.6	1.6	0	Low
Cliff Creek Lakes									
Cliff Creek Lake #1	1150329444797	2407	1.2	1.3	1.3	0.0	1.3	0	Rare
Cliff Creek Lake #2	1150404444786	2472	0.9	--	--	0.0	1.3	0	Rare
Cliff Creek Lake #3	1150358444837	2472	0.4	--	--	0.0	1.3	0	Rare
Cliff Creek Lake #5	1150439444816	2532	0.6	1.8	1.8	0.0	2.4	0	Rare
Iron Creek Lakes									
Iron Creek Lake #6	1150367441642	2576	1.3	7.0	7.0	1.6	3.2	0	Rare
Iron Creek Lake #7	1150434441672	2729	1.3	3.2	3.2	1.6	3.2	0	Rare

Table 5. Lakes surveyed in 2017 that did not contain fish. Includes stocking information, amphibian presence, and comments relating to fish status if applicable.

Drainage/ lake name	Species stocked	Stocking density (fish/ha)	Amphibians present[a]	Gill netted?	Comments
Alpine Creek Lakes					
Alpine Creek Lake #2	WCT	309.2	none	Y	Appears to have winterkilled. Numerous dead fish observed.
Vanity Summit Area					
Bear Creek Lake #1	WCT	163.1	none	Y	Anglers reported visiting several times and never catching fish.
Island Lake	RBT	312.6	none	Y	Gill netting and angling produced no fish.
Vanity Lake #5	WCT	118.0	none	Y	Angler reported large WCT in the lake a few years ago.
Float Creek Drainage					
Harlan Creek Lake #2	WCT	241.0	none	Y	Fairly shallow. Poor access.
Soldier Creek Drainage					
Muskeg Lake #2	none	--	none	N	Appears too shallow to hold fish over winter
Soldier Lake #3	none	--	LTS	N	Appears too shallow to hold fish over winter
Soldier Lake #3A	none	--	LTS	N	Appears too shallow to hold fish over winter
Soldier Lake #6	none	--	LTS	N	Appears too shallow to hold fish over winter
Kidney Lakes					
Kidney Lake #1	none	--	CSF, LTS	N	Appears too shallow to hold fish over winter
Kidney Lake #2	WCT	125.8	CSF	Y	Possible winterkill. Appears deep enough to hold fish.
Kidney Lake #3	none	--	CSF	N	Appears too shallow to hold fish over winter
Iris Lakes					
Iris Lake #1	WCT	116.3	LTS	Y	Possible winterkill. Appears deep enough to hold fish.
Cliff Creek Lakes					
Cliff Creek Lake #2	none	--	none	N	Appears deep enough to hold fish in a few spots.
Cliff Creek Lake #5	none	--	CSF	Y	Very small lake. Likely not deep enough to support over wintering.

Table 6. List of stocking recommendations for high mountain lakes in 2018 as a result of 2017 surveys.

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	# stocked	Recommended change	Recommended species	Recommended stocking density (fish/ha)	# to be stocked in 2018
Alpine Creek Lakes							
Alpine Creek Lake #2	WCT	309.2	371	discontinue	n/a	0	0
Alpine Creek Lake #4	GRA	28.9	367	increase density	GRA	80.1	1,017
Alpine Creek Lake #5	RBT	115.5	127	none	RBT	115.5	127
Alpine Creek Lake #6	WCT	115.8	301	none	WCT	115.8	301
Alpine Creek Lake #7	WCT	126.3	341	none	WCT	126.3	341
Alpine Creek Lake #11	RBT	130.3	430	add GRA	RBT/GRA	130.3/75.8	430/250
Alpine Creek Lake #12	WCT	1,275.0	510	none	WCT	1,275.0	510
Alpine Creek Lake #13	GRA	73.7	497	none	GRA	73.7	497
Alpine Creek Lake #14	GRA	50.3	161	switch to WCT	WCT	254.7	815
Alpine Creek Lake #15	GRA	75.1	368	discontinue	n/a	0	0
Vanity Summit Area							
Baldwin Creek Lake	WCT	121.7	353	none	WCT	121.7	353
Bear Creek Lake #1	WCT	163.1	212	switch to catchables	RBT	n/a	n/a
Island Lake	RBT	312.6	1,563	none	RBT	312.6	1,563
Langer Lake #1	RBT	209.2	1,004	switch to WCT	WCT	254.0	1,270
Lower Island Lake	WCT	258.1	542	none	WCT	258.1	542
Rocky Lake	WCT	118.4	450	increase density	WCT	254.0	965
Ruffneck Lake	RBT	195.2	1,249	none	RBT	195.2	1,249
Vanity Lake #1	RBT	132.2	304	discontinue	n/a	0	0
Vanity Lake #4	RBT	120.5	253	none	RBT	120.5	253
Vanity Lake #5	WCT	118.0	118	none	WCT	118.0	118
Vanity Lake #7	RBT	135.3	203	none	RBT	135.3	203
Float Creek Drainage							
Harlan Creek Lake #1	WCT	250.8	301	none	WCT	250.8	301
Harlan Creek Lake #2	WCT	241.0	241	none	WCT	241.0	241
Hasbrook Lake #1	WCT	123.7	371	discontinue	n/a	0	0
Helldiver Lake	WCT	123.2	542	discontinue	n/a	0	0
Lost Lake	WCT	38.7	201	none	WCT	38.7	201
Soldier Creek Drainage							
Muskeg Lake #1	RBT	292.4	497	none	RBT	292.4	497
Muskeg Lake #3	RBT	216.1	497	none	RBT	216.1	497

Table 6 (continued)

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	# stocked	Recommended change	Recommended species	Recommended stocking density (fish/ha)	# to be stocked in 2018
Soldier Lake #1	none	n/a	n/a	add to rotation	RBT	333.3	300
Soldier Lake #2	none	n/a	n/a	add to rotation	WCT	254.0	405
Soldier Lake #4	WCT	389.6	974	discontinue	n/a	0	0
Soldier Lake #7	WCT	200.8	241	discontinue	n/a	0	0
Soldier Lake #8	WCT	84.1	244	discontinue	n/a	0	0
Soldier Lake #9	WCT	221.8	244	discontinue	n/a	0	0
Soldier Lake #11	WCT	271.1	244	discontinue	n/a	0	0
Kidney Lakes							
Kidney Lake #2	WCT	125.8	151	none	WCT	125.8	151
Iris Lakes							
Iris Lake #1	WCT	116.3	221	discontinue	n/a	0	0
Iris Lake #3	WCT	121.8	341	none	WCT	121.8	341
Cliff Creek Lakes							
Cliff Creek Lake #1	WCT	117.5	141	none	WCT	117.5	141
Iron Creek Lakes							
Iron Creek Lake #6	RBT	58.5	76	switch to WCT	WCT	254.0	330
Iron Creek Lake #7	RBT	58.5	76	switch to WCT	WCT	254.0	330

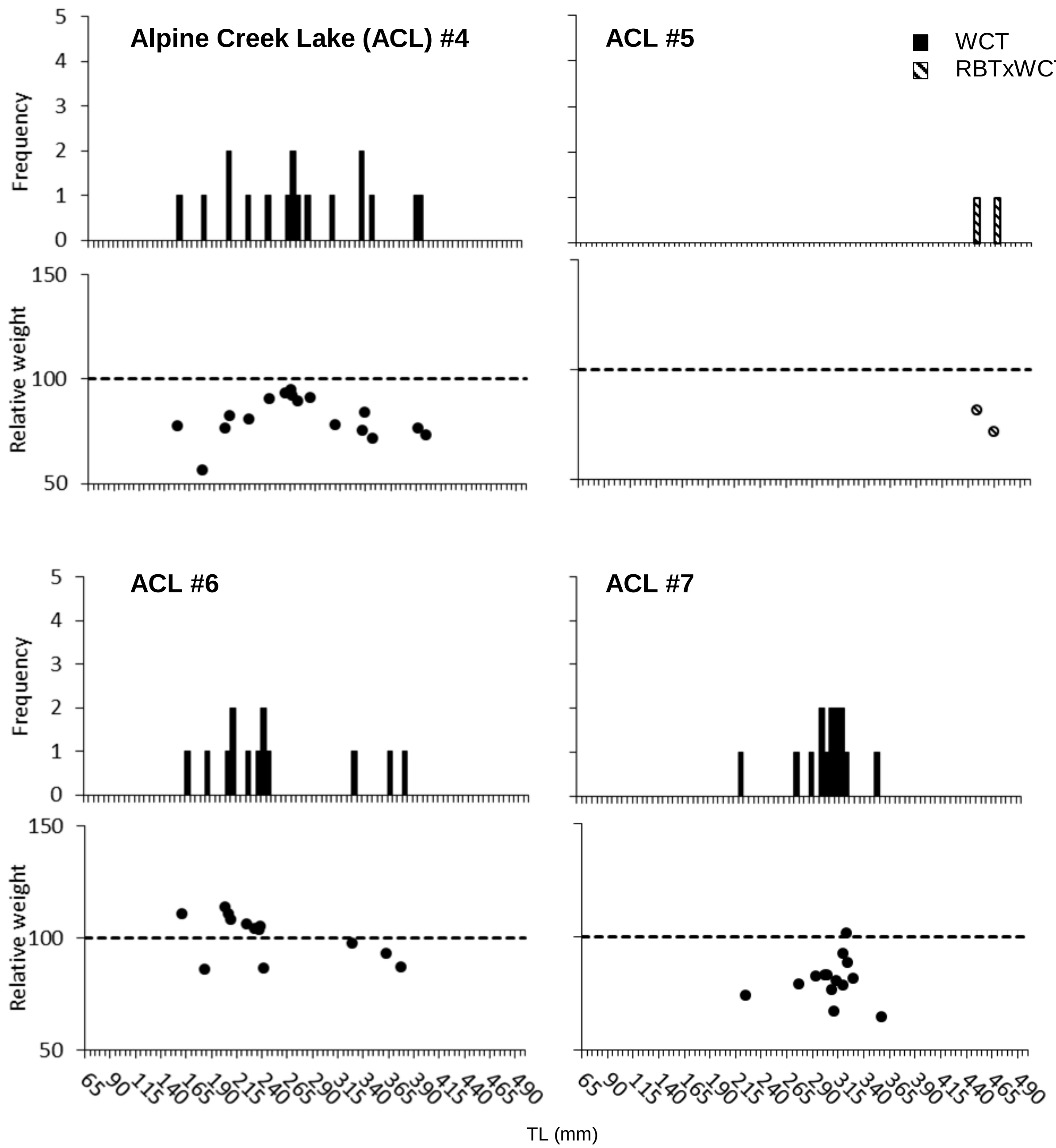
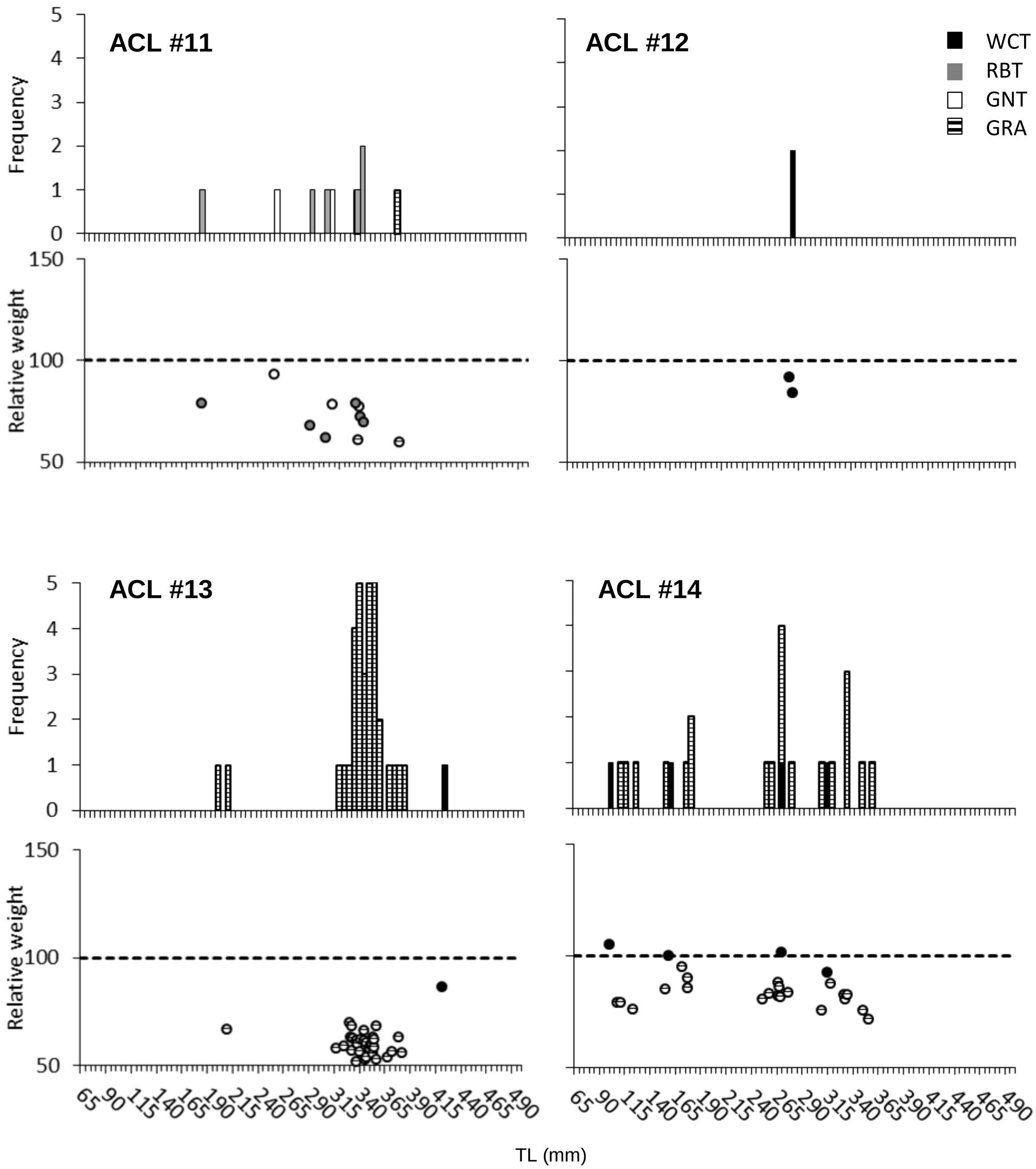


Figure 1. Length-frequency histograms and relative weights of all fish captured at lakes in the Alpine Creek Lakes Basin in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

Figure 1 (continued)



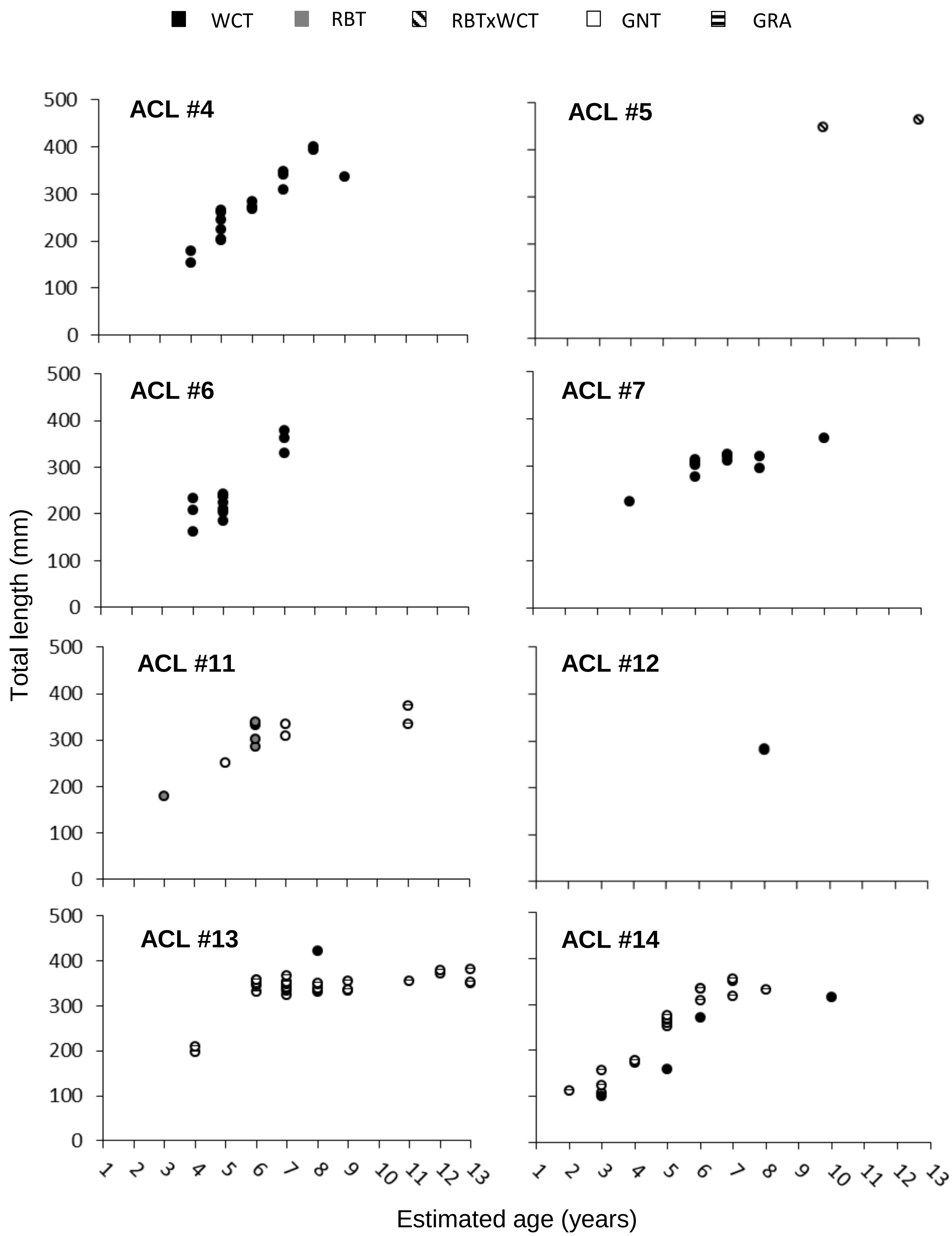


Figure 2. Length-at-age of all fish captured and aged from lakes in the Alpine Creek Lakes Basin in 2017.

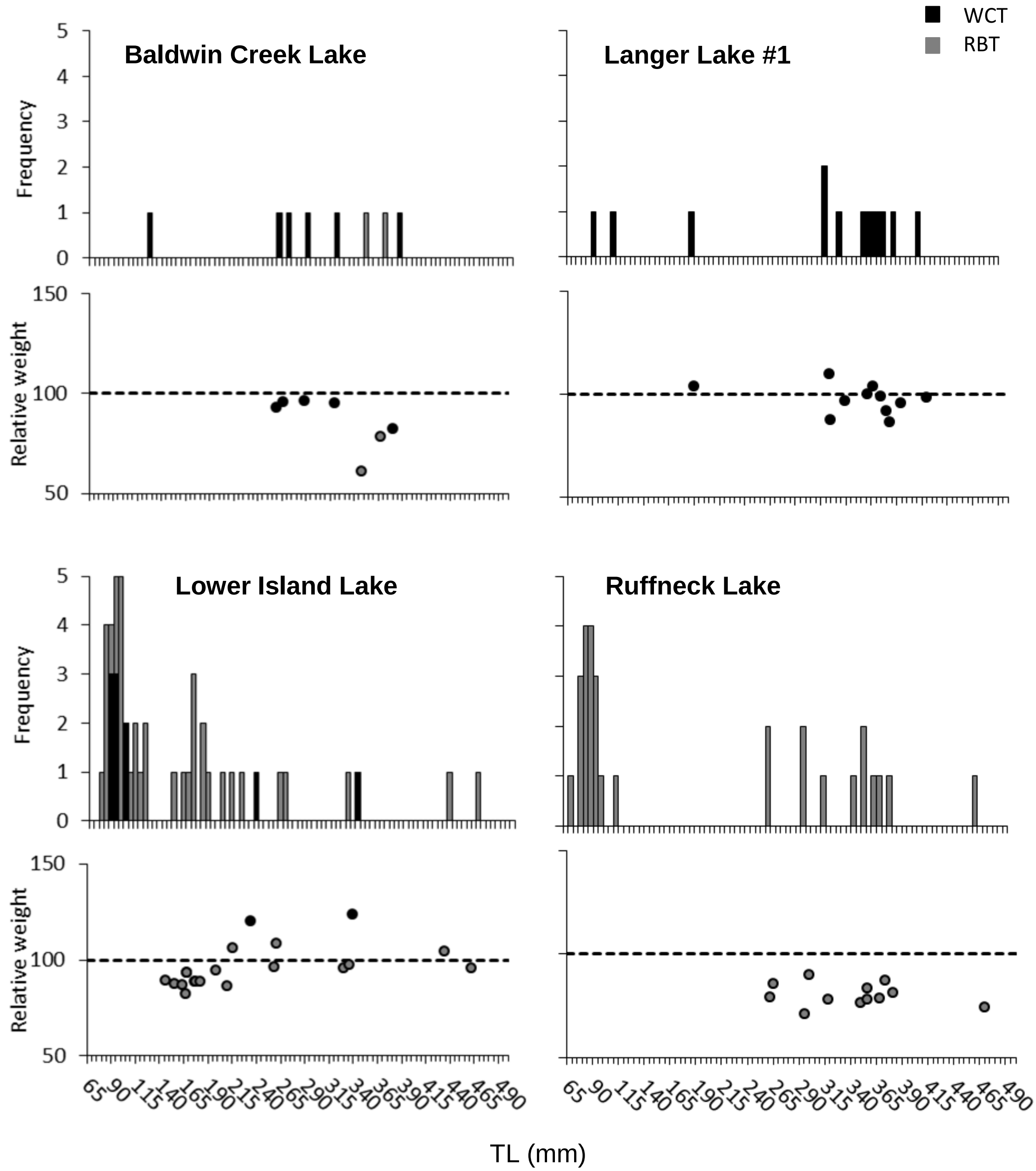
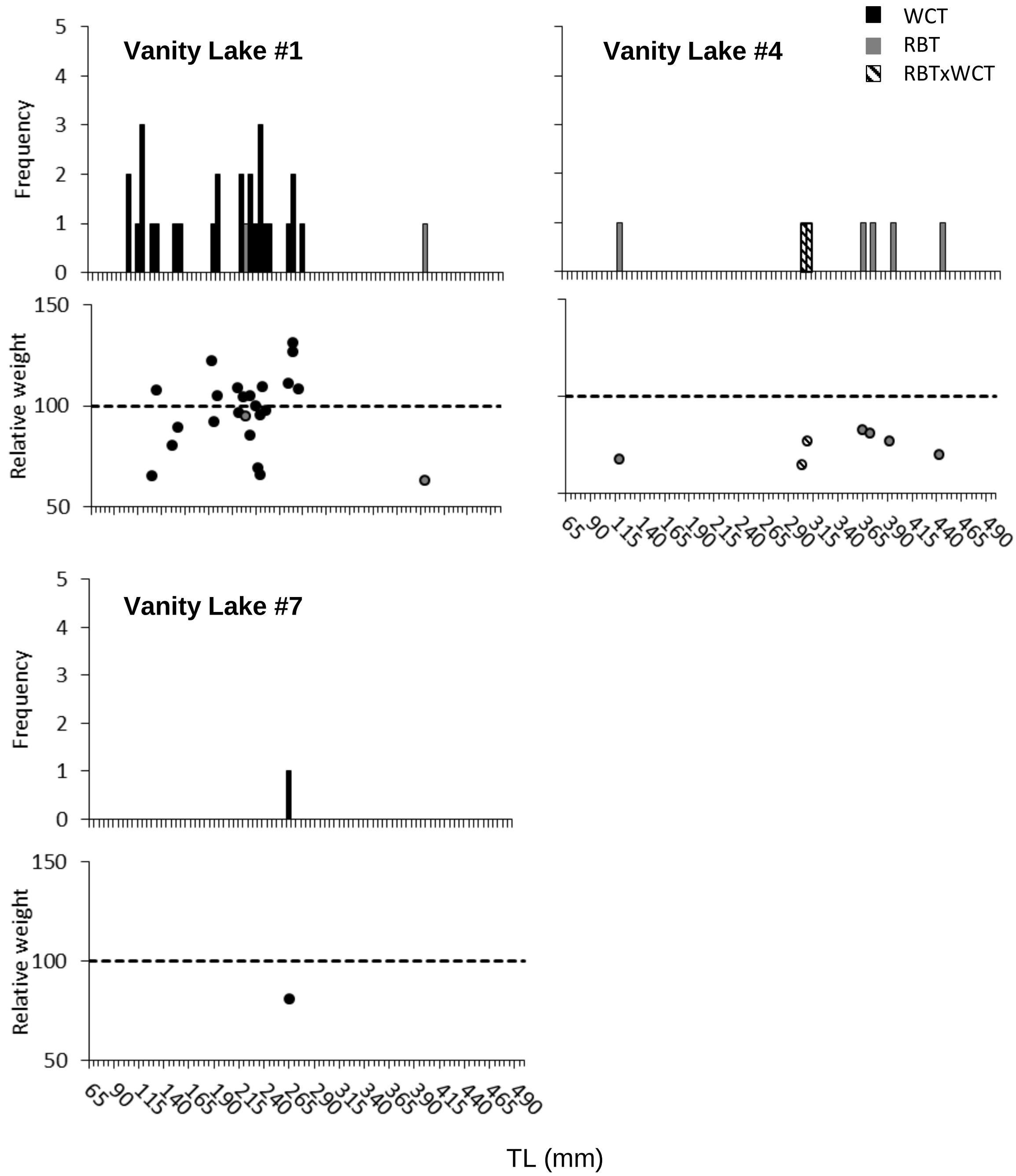


Figure 3. Length-frequency histograms and relative weights of all fish captured at lakes in the Vanity Summit Area in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

Figure 3 (continued)



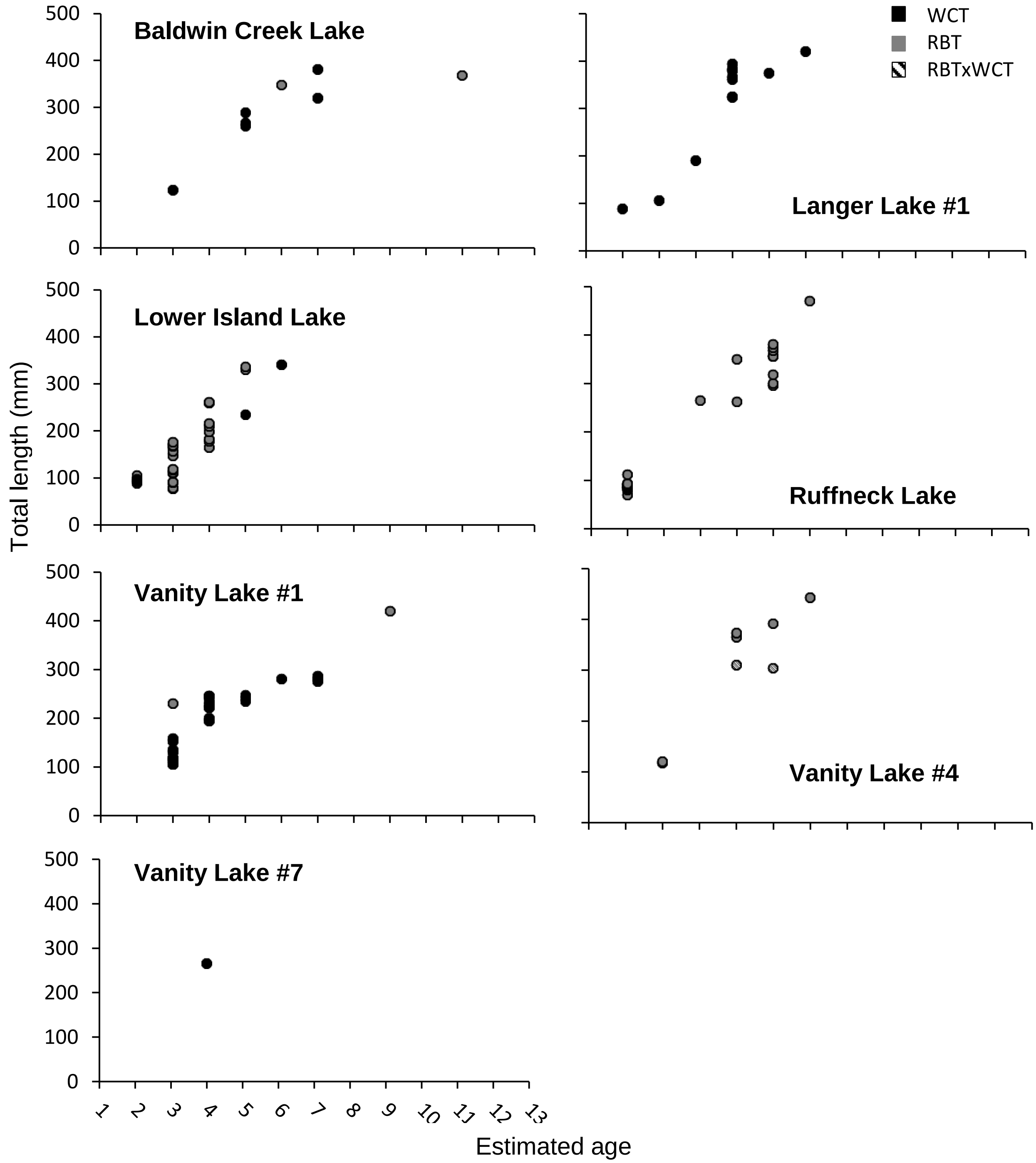


Figure 4. Length-at-age of all fish captured and aged from lakes in the Vanity Summit area in 2017.

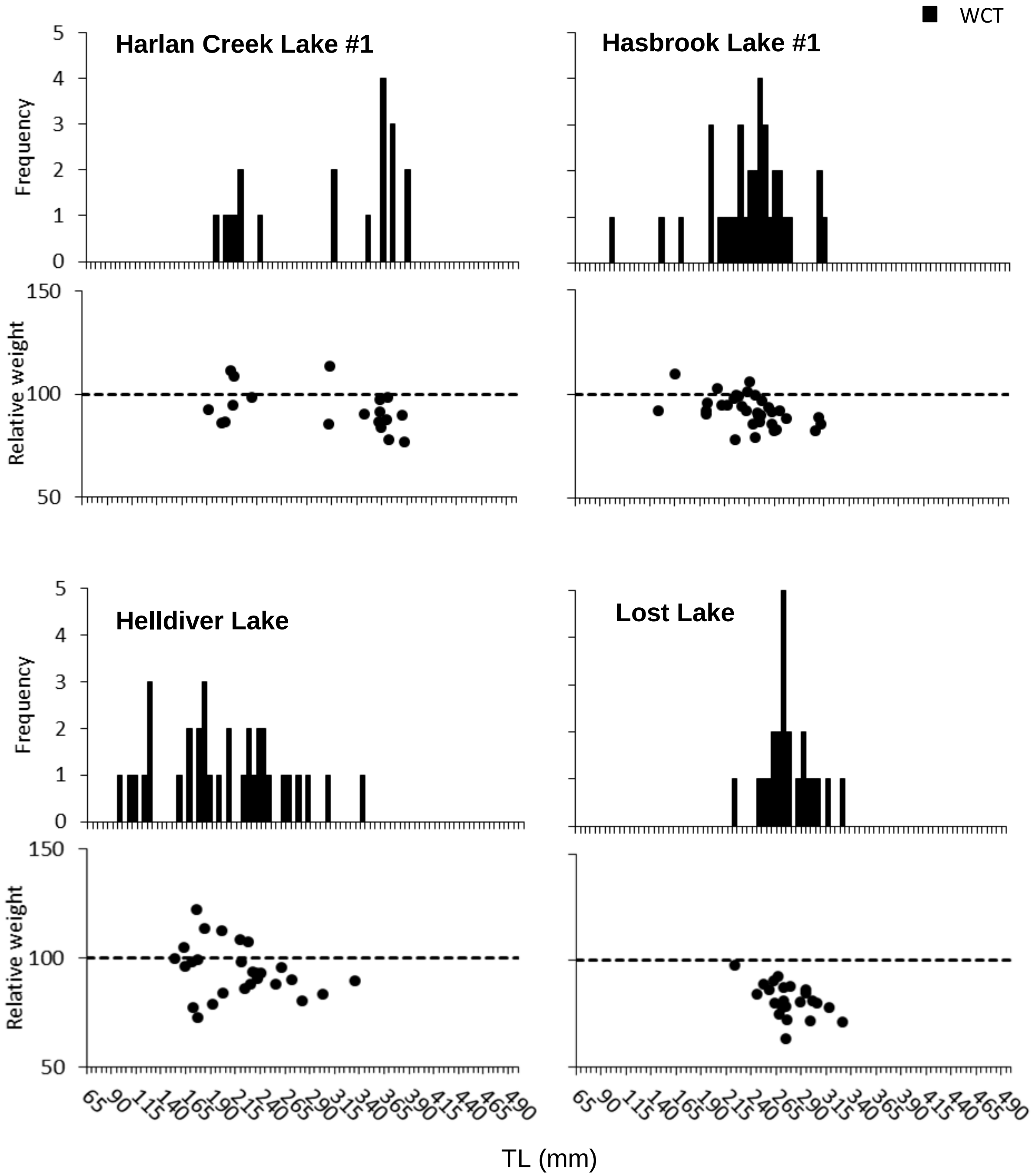


Figure 5. Length-frequency histograms and relative weights of all fish captured at lakes in the Float Creek Drainage in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

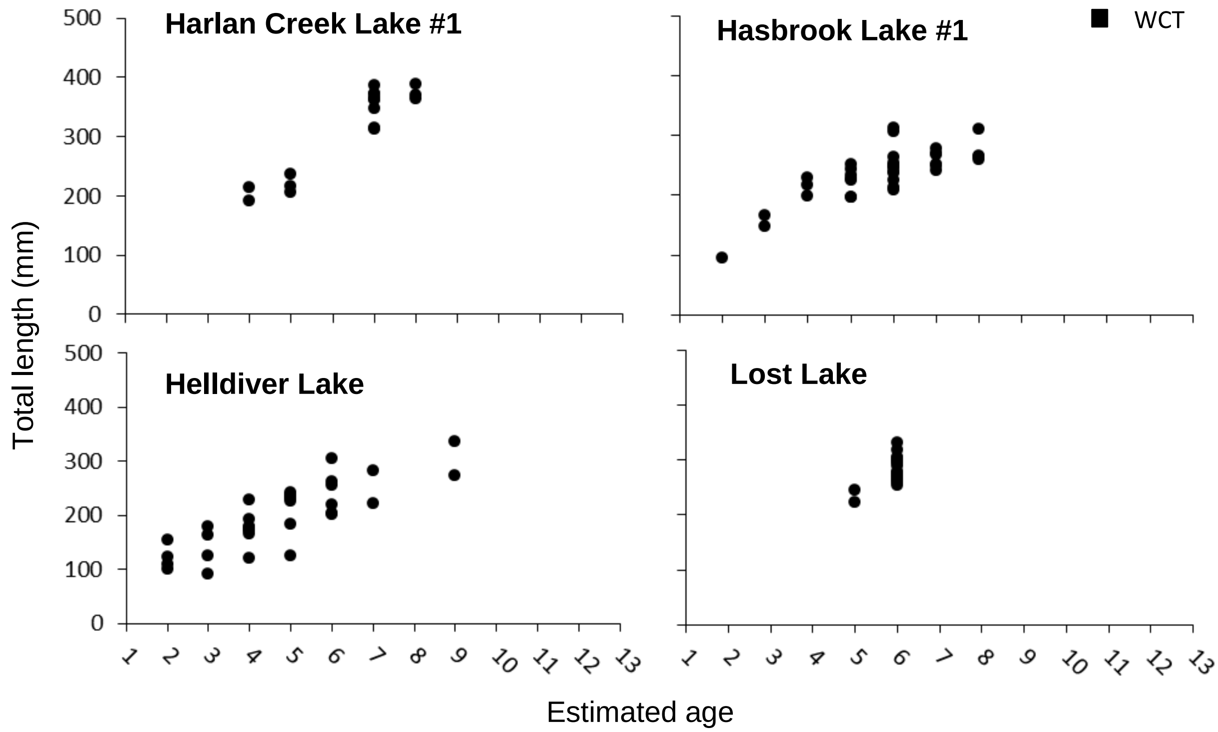


Figure 6. Length-at-age of all fish captured and aged from lakes in the Float Creek Drainage in 2017.

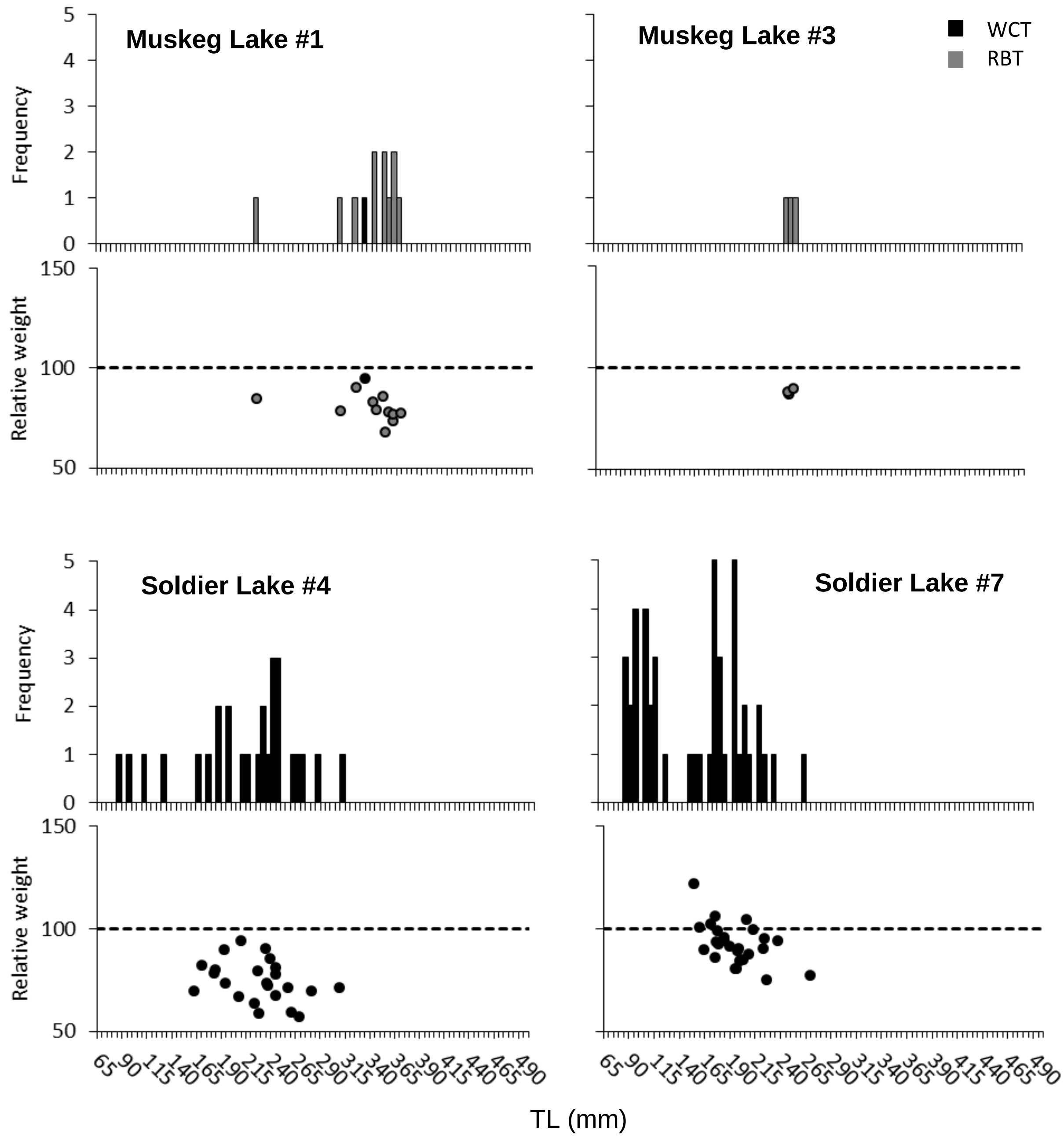
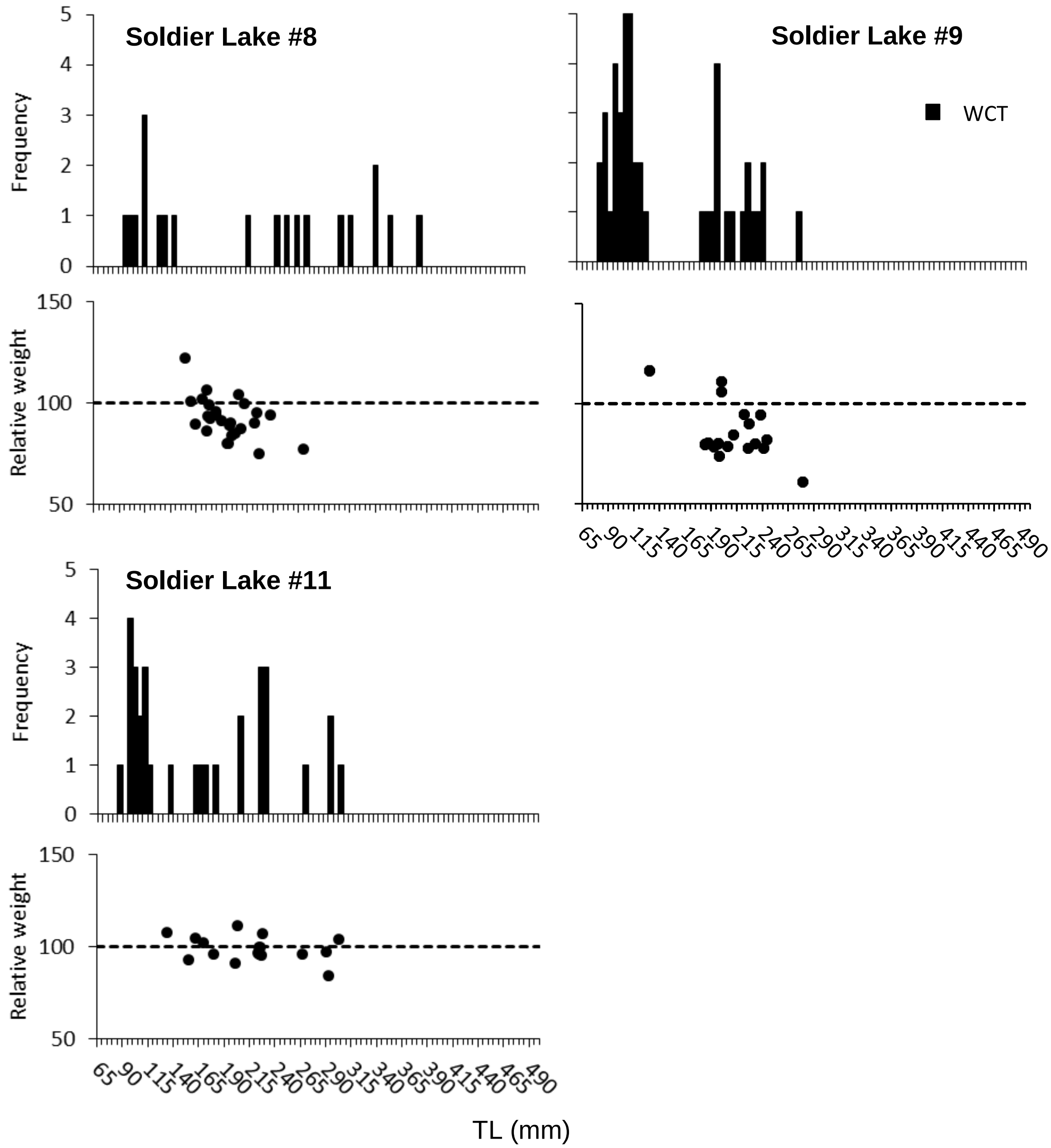


Figure 7. Length-frequency histograms and relative weights of all fish captured at lakes in the Soldier Creek Drainage in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

Figure 7 (continued)



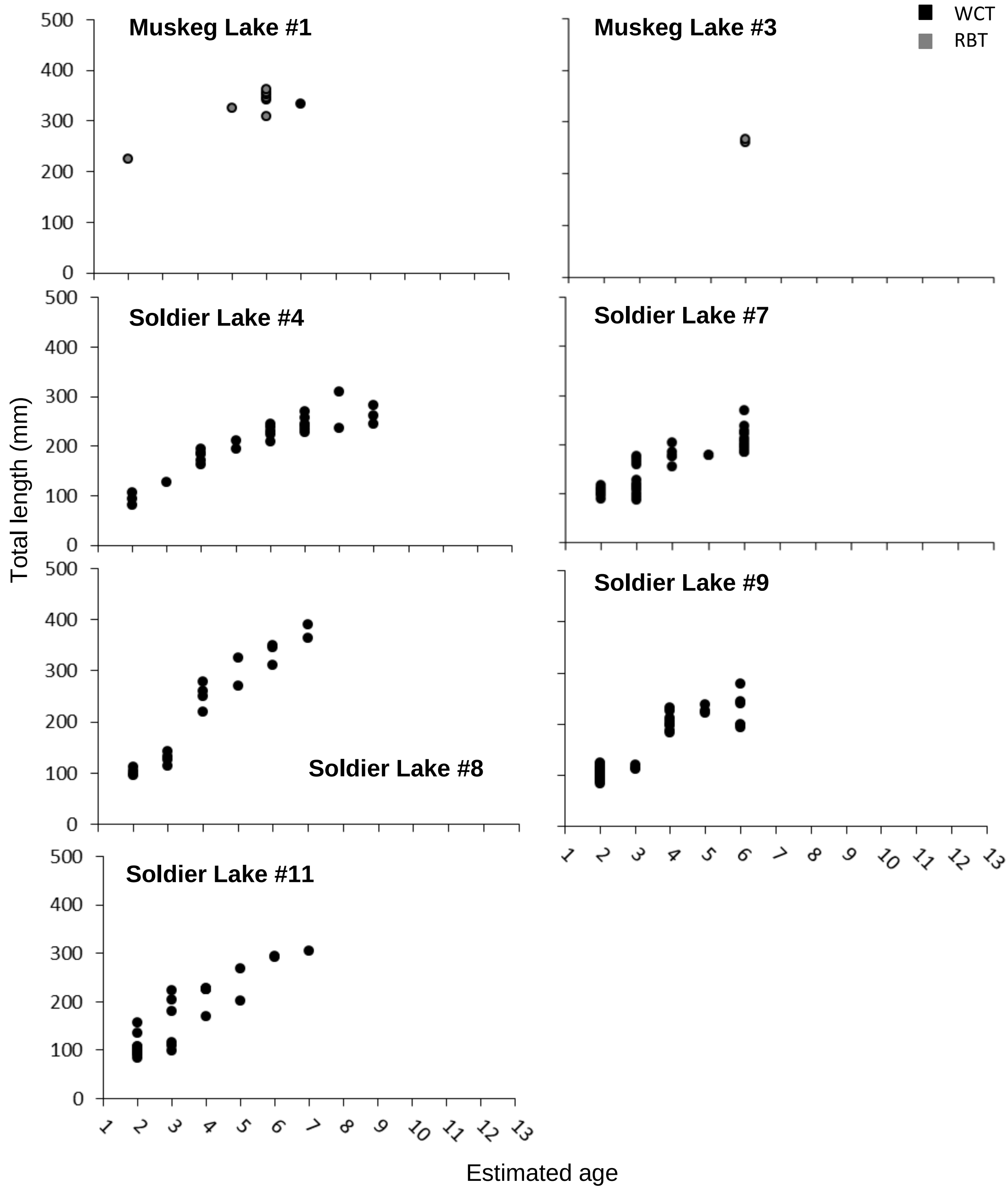


Figure 8. Length-at-age of all fish captured and aged from lakes in the Soldier Creek Drainage in 2017.

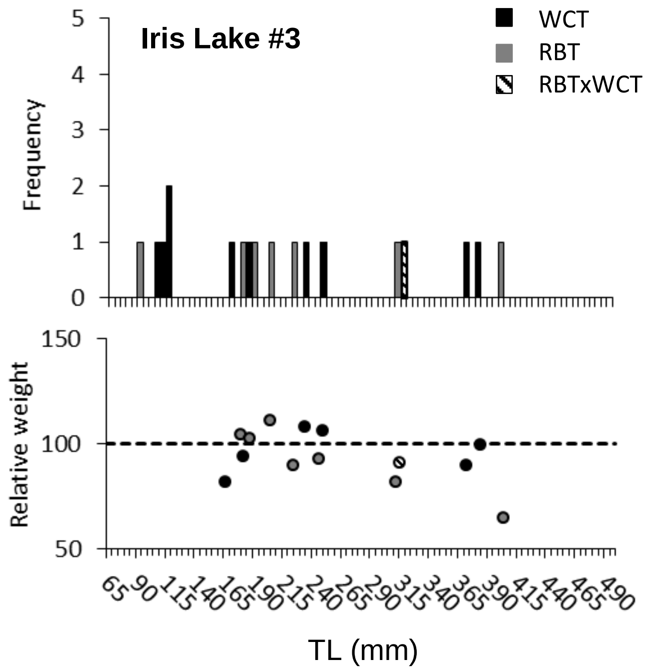


Figure 9. Length-frequency histograms and relative weights of all fish captured at lakes in the Iris Lakes Basin in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

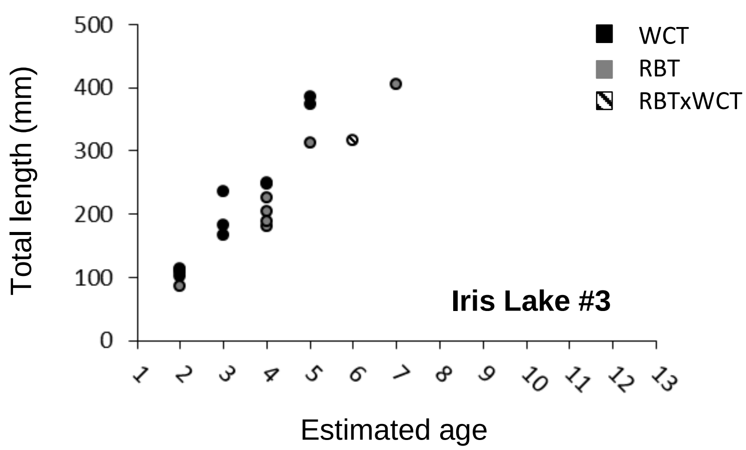


Figure 10. Length-at-age of all fish captured and aged from lakes in the Iris Lakes Basin in 2017.

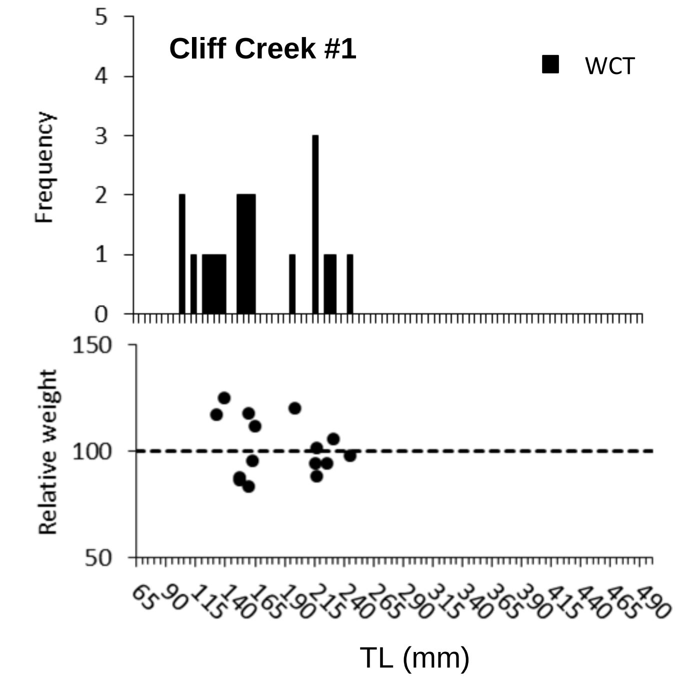


Figure 11. Length-frequency histograms and relative weights of all fish captured at lakes in the Cliff Creek Lakes Basin in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

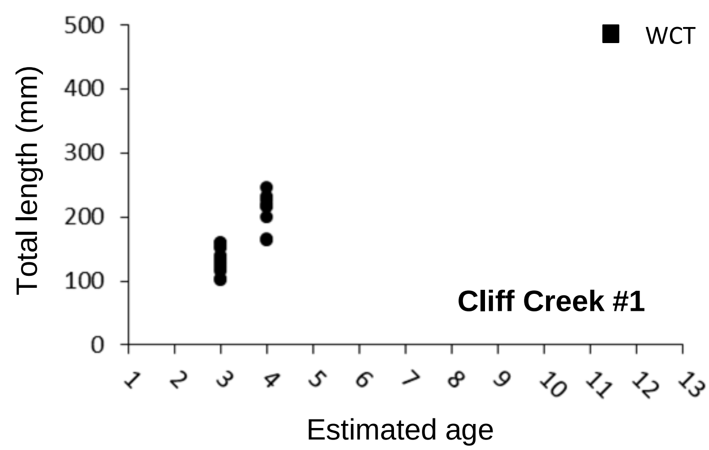


Figure 12. Length-at-age of all fish captured and aged from lakes in the Cliff Creek Lakes Basin in 2017.

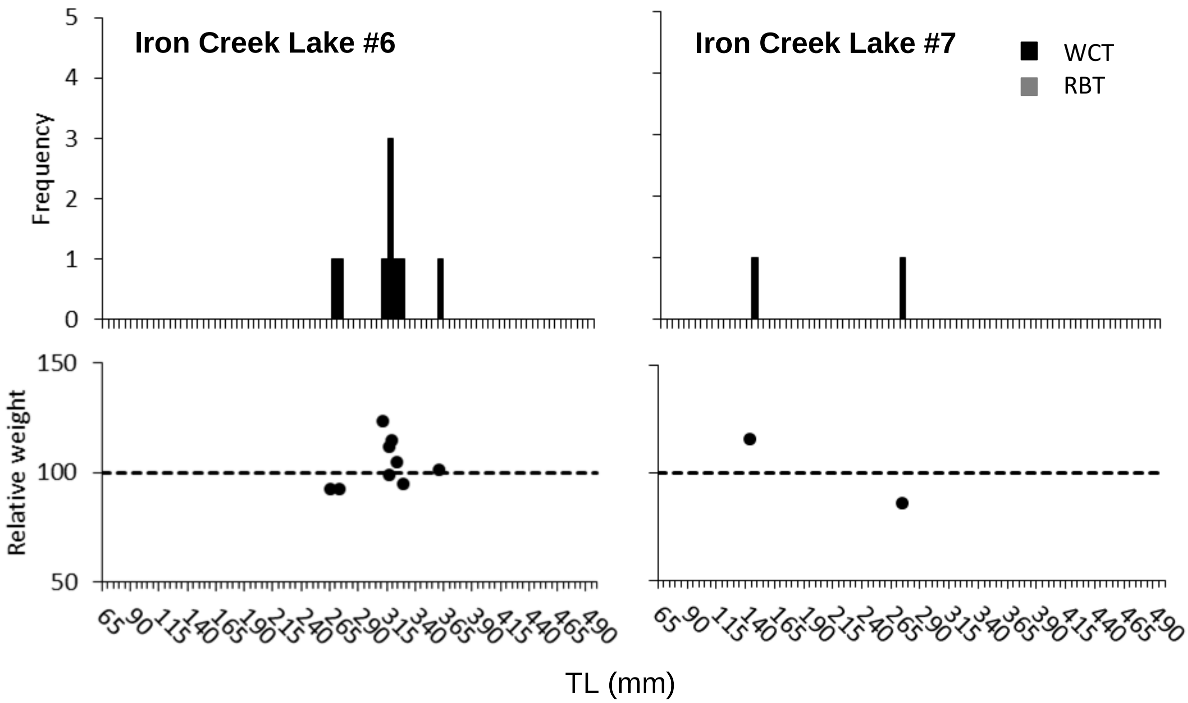


Figure 13. Length-frequency histograms and relative weights of all fish captured at lakes in the Iron Creek Lakes Basin in 2017. Dashed line represents W_r value of 100. Refer to Table 4 for sample sizes.

Figure 14. Length-at-age of all fish captured and aged from lakes in the Iron Creek Lakes Basin in 2017.

LOWLAND LAKES AND RESERVOIRS:

COMMUNITY PONDS STOCKING EVALUATION

ABSTRACT

We estimated return-to-creel rates for stocked catchable-size (~250 mm TL) Rainbow Trout *Oncorhynchus mykiss* in four community pond fisheries in the Salmon Region in 2017. We estimated total use (fish caught) and total exploitation (fish harvested) for several stocking events at each community pond using the Tag-You're-It program (Meyer et al. 2012; Cassinelli 2015). In 2017, we wanted to evaluate how increasing the stocking frequency at community ponds would affect return-to-creel rates. The same number of fish were stocked per month as in previous years, but those fish were spread out across two stocking events per month instead of one. At Kids Creek Pond and Hayden Creek Pond, estimated return-to-creel rates were higher in 2017 using this stocking regime than they were in previous years when fish were stocked only once per month. Very few tags were returned for stocked groups in Hyde Creek Pond and Blue Mountain Pond. These results suggest the stocking regime we tested in 2017 could likely improve fishing quality at community ponds, but higher sample sizes are likely needed to improve our estimates using the Tag-You're-It methodology.

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INTRODUCTION

Community ponds serve an important role in the Salmon Regional Fisheries Management program. Stocking catchable trout in community ponds throughout the year provides consistent opportunity for anglers, often a very short distance from home. In spring, when rivers and streams are high and muddy and higher elevation lakes are not yet accessible, community ponds are one of the few options available for anglers in the region. Typically, community ponds are stocked with catchable-size Rainbow Trout *Oncorhynchus mykiss* (averaging ~250 mm TL) once per month during ice-free months. Fishing in the community ponds is typically very good immediately following stocking, but can become slower over time until the next monthly stocking event. In 2017, we wanted to evaluate whether increasing the frequency of stocking events to twice per month could improve community pond angling opportunity. We stocked the same number of fish each month, but divided them into two stocking events two weeks apart, in order to determine whether overall use of stocked fish could be improved. In theory, increasing the frequency of stocking events could help provide more consistency for community pond anglers, as stocked fish are spread more evenly throughout each month.

OBJECTIVES

1. Evaluate use and exploitation rates for each group of catchable Rainbow Trout stocked in four community ponds in 2017.

2. Compare use and exploitation rates for 2017 (increased frequency of stocking events) to previous rates based on single monthly stocking events, and determine the most appropriate method for stocking community ponds in the future to maximize angler opportunity and overall use of stocked fish.

STUDY SITES

Blue Mountain Pond (WGS84 datum: 44.50119ºN, 114.23923ºW) is a 0.27 ha community fishing pond located within the city of Challis. The pond is typically de-watered during winter months, and is filled in the spring to provide recreational put-and-take fishing opportunity for the Challis community. IDFG provided in-kind matching funds (~$60,000) to build the pond in 1998, and we have been stocking the pond with ~900 to ~2,300 catchable Rainbow Trout per year since 1999. Additionally, adult steelhead (anadromous *O. mykiss)* and jack Chinook Salmon *O. tschawytscha* are stocked in the pond if excess are available at Pahsimeroi or Sawtooth hatcheries. In 2017 we stocked ~300 Rainbow Trout during each of four stocking events (May, June, July, and September) and we stocked 150 in August. By comparison, in 2015 we stocked ~300 Rainbow Trout during each of three stocking events (May, June, and September). Unlike the other three community ponds in this section of the report, stocking frequency was not increased in Blue Mountain Pond in 2017 because it was logistically difficult for hatchery transport.

Kids Creek Pond (WGS84 datum: 45.16807 ºN, 113.88980ºW) is a 0.19-ha community fishing pond located within the city of Salmon. IDFG purchased the 0.70 ha property in 1991 and worked with City and County government, federal and state agencies, the Salmon School District, and local citizens to build the pond and make additional improvements to the property over the coming years to benefit local citizens and promote natural resource education. The pond was excavated in 1992, and additional improvements were made including a vault toilet, handicap accessible walkway and dock, gazebo and picnic area, natural landscaping, and natural resource interpretive signs. In 1994, IDFG and the city of Salmon entered into an agreement stating that IDFG would maintain and manage the pond (including water management and fish stocking) and the city would maintain other public services (e.g. toilets and water) on the property. Since then, IDFG has made several improvements to the pond, including dredging additional sediment from the pond, installing flood protection structures, and routine maintenance to remove algae buildup. Kids Creek Pond is a very popular fishery, especially among the local youth. IDFG stocks approximately 1,500 to 2,500 catchable Rainbow Trout in the pond annually, from February through November. Additionally, adult steelhead and jack Chinook Salmon are stocked in the pond if excess are available at the Pahsimeroi Hatchery. In 2017, we evaluated exploitation and use rates for two stocking events in June (150 fish each), two stocking events in July (150 fish each), and single stocking events in August and September (300 fish each). By comparison, in 2014 we evaluated exploitation and use rates for 300 catchable Rainbow Trout stocked during one event in June.

Hayden Creek Pond (WGS84 datum: 44.83873ºN, 113.66204ºW) is a popular community fishery located approximately 45 km southeast of Salmon, Idaho, in the Lemhi River drainage. Hayden Creek Pond was consolidated from two smaller ponds to one larger pond in 2012 to improve fishing. The two ponds were part of the Hayden Creek Hatchery that existed at that location prior to 1994. The current pond is 0.57 ha in size and sits at 1,650 m in elevation. Hayden Creek Pond is easily accessible by paved road, is wheelchair accessible, and is open to fishing year-round. The region manages Hayden Creek Pond as a put-and-take fishery with general bag and possession limits (six trout per day). Stocking catchable Rainbow Trout throughout the year (February through November) is intended to provide angling opportunity with high catch rates all season long. Over the last five years, Hayden Creek Pond has received 2,700 to 5,000 catchable Rainbow Trout annually. In June and July 2017, we stocked 300 catchable trout in Hayden Pond, twice per month, and evaluated exploitation and use for comparison with 2014 June and July rates. Exploitation and use rates were also evaluated for single stocking events in May, August, and September, 2017. In 2014, exploitation and use of hatchery catchable trout was evaluated for seven stocking events (April, May, June, July, August, September, and November). For June and July, 2014, 600 catchable trout were stocked once per month.

Hyde Creek Pond (WGS84 datum: 45.09404ºN, 113.88173ºW) is a 0.36 ha community fishing pond located ~9.5 km south of the town of Salmon. The land surrounding the pond is owned by the Bureau of Land Management (BLM), and the water right for the pond belongs to Hyde Creek Ranch. However, IDFG has been stocking the pond and managing it as a put-and-take fishery since 1994. In 2017, IDFG worked with the owner of the water right to make improvements to the pond including removing vegetation from the bank and reinforcing the dyke. Hyde Creek Pond is one of the few waterbodies in the region that provides easily accessible ice fishing opportunity during winter months. In January each year, approximately 80 to 100 participants (age 16 and under) take part in an annual kids ice fishing derby at Hyde Creek Pond. Hyde Creek Pond is stocked throughout the year to provide ice fishing opportunity during winter months and bank fishing opportunity during the ice-free season. Approximately 900 to 1,300 catchable Rainbow Trout are stocked annually, but warm water temperatures in late July through September usually result in heavy algae growth in the pond, so those months are typically not stocked. Additionally, adult steelhead and jack Chinook Salmon are stocked in the pond if excess is available at nearby hatcheries. In 2017, we evaluated exploitation and use rates for 200 catchables stocked during one event in May, 200 catchables stocked during two events in June, and 150 catchables stocked during one event in September. We were mainly interested in comparing June results for 2012 and 2017, to see how decreasing stocking density and increasing stocking frequency would affect return-to-creel. In 2012, exploitation and use rates were evaluated for 272 catchables stocked during one event in June and for 240 catchables stocked during one event in November.

METHODS

Return-to-creel rates were assessed for select catchable Rainbow Trout stocking events at Blue Mountain Pond, Kids Creek Pond, Hayden Creek Pond, and Hyde Creek Pond in 2017, and were also assessed for the first of three stocking events for catchable tiger trout stocked in Wallace Lake (summarized in Wallace Lake section of this report).

Total use (fish caught) and exploitation (fish harvested) were evaluated for hatchery-produced catchable Rainbow Trout in four water community ponds, and tiger trout in one water body (discussed in Chapter Three of this report) in the Salmon Region in 2017. Each of these four community ponds are stocked with catchable Rainbow Trout several times each year, and Wallace Lake was stocked with catchable tiger trout three times in 2017. A proportion of stocked fish during each stocking event are tagged, and use and exploitation estimates for each stocked group of fish, based on tags reported, are adjusted by factoring in estimated tag reporting rates, estimated tag-loss rates, and estimated tagging mortality rates (Cassinelli 2015). For selected stocking events in 2017, 10% of stocked fish were marked with FLOY™ t-bar anchor tags for exploitation analysis. Tags used for this study were printed with a unique numerical code and information for anglers to report caught and harvested fish (Cassinelli 2014). IDFG contact information on the tags directed anglers to report tags to the Nampa Fish Research office where the data is stored. Estimated total use and exploitation for each stocking event were calculated based on methods reported in Meyer et al. (2010). We used the same statewide angler reporting rate estimate (58.0% in 2014) and statewide estimated tag-loss rate (2.5% for first year at large) used in the 2015 report (Messner et al. 2017) to calculate adjusted harvest and catch estimates in 2017. The estimated tagging mortality rate is a constant (0.8%, from Cassinelli 2014). In this report, we only generated estimates for each stocking group’s first year at large. Estimates for adjusted use and exploitation (u') were calculated using the formula:

$$u' = \frac{u}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

Where:
u = unadjusted harvest/catch rate
λ = angler tag reporting rate
Tag_l = first year tag-loss rate
Tag_m = tagging mortality rate

Ninety percent (90%) confidence intervals were calculated for all harvest and catch estimates. For more information and details regarding these methods and associated formulas, see Meyer et al. (2010).

RESULTS AND DISCUSSION

Blue Mountain Pond

In Blue Mountain Pond, four tagged fish were reported as harvested from the May stocking event, one tagged fish was reported harvested from the June stocking event, and one tagged fish was reported as caught and released from the September stocking event in 2017 (Table 7). Tag reports resulted in estimated use rates of 23.8% in May, 5.9% in June, and 5.9% in September (Table 7). Estimated use for all other months was zero, as no tags were reported (Table 7). Use and exploitation estimates for 2017 were very similar to estimates for 2015 in May and September (Figure 15). In June 2017 however, estimated use was lower than in June 2015, and no tagged fish were reported from the July and August stocking events in 2017 (Figure 15).

We believe use and exploitation on these groups of stocked fish is actually much higher than our 2017 estimates suggest. In June each year, IDFG and the USFS host a Free Fishing Day kids fishing derby at Blue Mountain Pond where hundreds of stocked fish are caught and harvested, and fishing effort generally remains high at the pond throughout the summer. The 2017 estimates of use and exploitation in Blue Mountain Pond may indicate that either: 1) stocked fish did not return to the creel, 2) tag loss was higher than anticipated or 3) reporting rates are much lower than the 58% used to calculate our estimates. We are unsure what may have caused the discrepancy between our observations of high use or effort and low calculated exploitation and use from the Tag-You're-It program. Increasing the number of tagged fish from each stocking event would likely increase the chances of tagged fish returns and narrow the bounds on our confidence intervals. In addition, we plan to assess summer water quality and use patterns with a modified creel or camera survey.

Kids Creek Pond

In Kids Creek Pond, a total of 20 fish were reported as caught between the six stocking events (Table 7). Monthly use estimates ranged from 5.9% for the group stocked in September to 52.4% for the group stocked in the latter half of July (Table 7). Estimated total use and exploitation was very similar between each of the two stocking events in June, and each of the two stocking events in July (Figure 16). Estimated use for both of the stocking events in June 2017 were slightly higher than the estimated use for a single June stocking event in 2014 (Figure 16). Overall, we saw the highest use on fish stocked in July, and use tapered off in September (Figure 16).

Although our sample size is low, it appears increasing the stocking frequency at Kids Creek Pond in 2017 was beneficial to pond anglers. Stocking every two weeks helped improve consistency on the availability of fish throughout the summer, and return rates remained relatively high for all stocking events in June and July, when stocking frequency was increased. For June stocking in 2017, over twice as many fish were reported as caught when compared to the same number of fish stocked during a single stocking event in 2014 (Figure 16). Based on these findings, if feasible, we recommend continuing stocking at a higher frequency throughout the summer months at the pond to improve consistency in angling opportunity and increase returns. Additionally, as mentioned in the previous section, investigation into actual reporting rates and/or increasing the number of tagged fish in these community ponds could help improve our estimates.

Hayden Creek Pond

In Hayden Creek Pond, 53 tagged fish were reported as caught between the seven stocked groups (Table 7). Total use estimates ranged from 19.0% for the group of fish stocked in August to 59.4% for the group of fish stocked the first week of July (Table 7). In general, use was highest for groups of fish stocked in the spring/early summer than for groups stocked in late summer/early fall (Figure 17). Increasing our stocking frequency at Hayden Creek Pond in June and July 2017 seemed to be beneficial in terms of maximizing use of stocked fish. We estimated total use for fish stocked during each of the two events in June 2017 averaged 47.5% while estimated use on fish stocked in June 2014 in the pond was only 13.5% (Figure 17). Similarly, estimated total use for fish stocked during each of the two events in July 2017 averaged 44.6% while estimated use on fish stocked in July 2014 in the pond was only 19.2% (Figure 17). Return-to-creel estimates for all other months compared in 2014 and 2017 were relatively similar (Figure 17). These results further suggest that increased stocking frequency is beneficial for maximizing use of catchable trout at these community ponds.

Hyde Creek Pond

In Hyde Creek Pond, only two tagged fish were reported as caught out of 55 tagged fish between four stocking events (Table 7). Both fish were stocked during the same event on June 19, so estimated use for that stocking event was 35.7%, while all other stocking events had estimated use values of 0.0% (Table 7). Estimated use for fish stocked during the June 19 event in 2017 was similar to values estimated for June 2012 (Figure 18). However, since no tags were reported from the June 5 stocking event in 2017, our comparison of stocking frequencies is difficult. Similar to what was discussed for the other community ponds in this chapter, we would likely increase our ability to get at least one tag returned from these stocked groups if we increased our tagging sample size.

Community ponds in the Salmon Region demonstrated a wide range of use and exploitation of stocked hatchery trout during 2017. Tag returns from Blue Mountain Pond and Hyde Creek Pond were limited, and it is unclear if this reflects actual limited return to creel or is due to low tag reporting rates. Further investigations should increase the sample size of tagged fish stocked into these ponds, and examine the actual angler effort at these ponds throughout the summer.

MANAGEMENT RECOMMENDATIONS

1. When logistically feasible, increase stocking frequency for community ponds to twice per month.

2. Conduct periodic angler surveys at community ponds to ensure catch rates remain adequate.

3. Consider using remote creel techniques (i.e. trail cameras) at Hyde Creek and Blue Mountain ponds to estimate angler effort. .

Table 7. Estimated angler exploitation (fish harvested) and total use (fish caught) of catchable Rainbow Trout (RBT) stocked in 2017 in community fishing ponds, up to January 4, 2018.

				Disposition			Adjusted exploitation		Adjusted total use	
Water body	Tagging date	Species	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Blue Mountain Pond	5/22/17	RBT	30	4	0	0	23.8%	23.4%	23.8%	23.4%
	6/5/17	RBT	30	0	1	0	0%	0%	5.9%	12.1%
	7/3/17	RBT	30	0	0	0	0%	0%	0%	0%
	8/17/17	RBT	15	0	0	0	0%	0%	0%	0%
	9/14/17	RBT	30	0	0	1	0%	0%	5.9%	12.1%
	overall	RBT	135	4	1	1	5.3%	5.5%	7.9%	12.1%
Kids Creek Pond	6/5/17	RBT	15	2	0	1	23.8%	32.6%	35.7%	38.7%
	6/19/17	RBT	15	2	0	0	23.8%	32.6%	23.8%	32.6%
	7/3/17	RBT	15	3	0	1	35.7%	38.7%	47.5%	43.1%
	7/17/17	RBT	17	2	0	3	21.0%	29.0%	52.4%	42.1%
	8/17/17	RBT	30	3	0	2	17.8%	20.5%	29.7%	25.8%
	9/11/17	RBT	30	1	0	0	5.9%	12.1%	5.9%	12.1%
	overall	RBT	122	13	0	7	21.3%	9.9%	32.9%	12.7%
Hayden Creek Pond	5/23/17	RBT	30	5	1	0	29.7%	25.8%	35.7%	27.9%
	6/5/17	RBT	30	8	0	0	47.5%	31.3%	47.5%	31.3%
	6/19/17	RBT	30	7	1	0	41.6%	29.7%	47.5%	31.3%
	7/3/17	RBT	30	7	1	2	41.6%	29.7%	59.4%	34.1%
	7/17/17	RBT	30	5	0	0	29.7%	25.8%	29.7%	25.8%
	8/17/17	RBT	75	7	1	0	16.6%	12.8%	19.0%	13.7%
	9/11/17	RBT	60	6	1	1	17.8%	14.7%	23.8%	16.9%
	overall	RBT	285	45	5	3	31.7%	9.7%	37.0%	10.8%
Hyde Creek Pond	5/23/17	RBT	20	0	0	0	0%	0%	0%	0%
	6/5/17	RBT	10	0	0	0	0%	0%	0%	0%
	6/19/17	RBT	10	2	0	0	35.7%	47.1%	35.7%	47.1%
	9/11/17	RBT	15	0	0	0	0%	0%	0%	0%
	overall	RBT	55	2	0	0	9.5%	9.7%	9.5%	9.7%

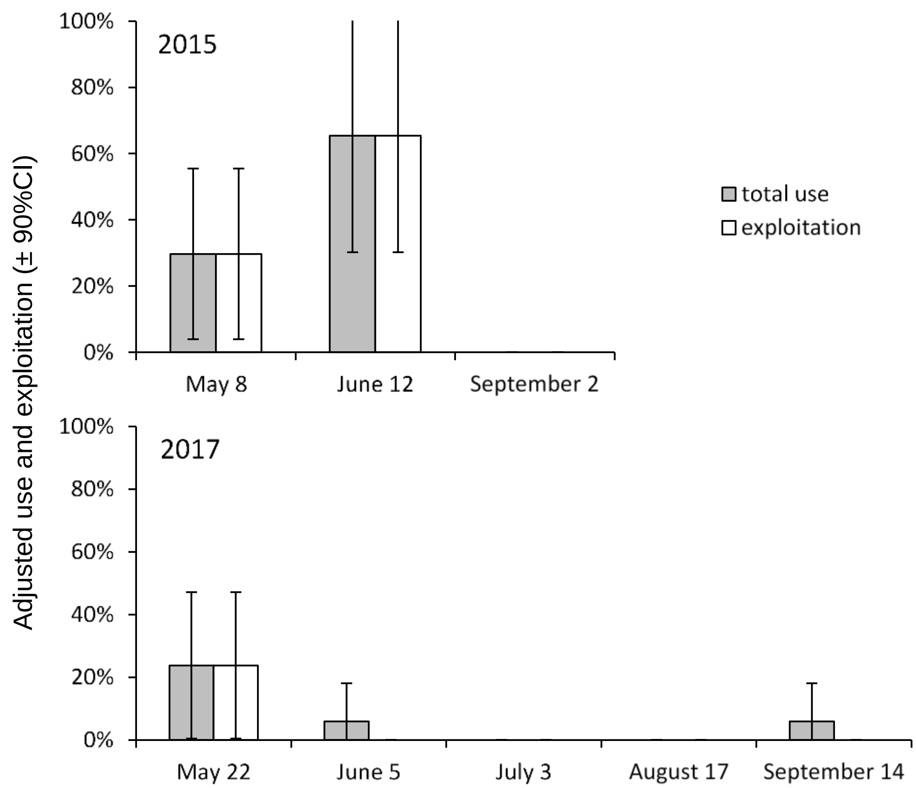

Figure 15. Overall estimated total use (catch) and exploitation (harvest) of catchable Rainbow Trout stocked during select events in Blue Mountain Pond in 2015 and 2017.

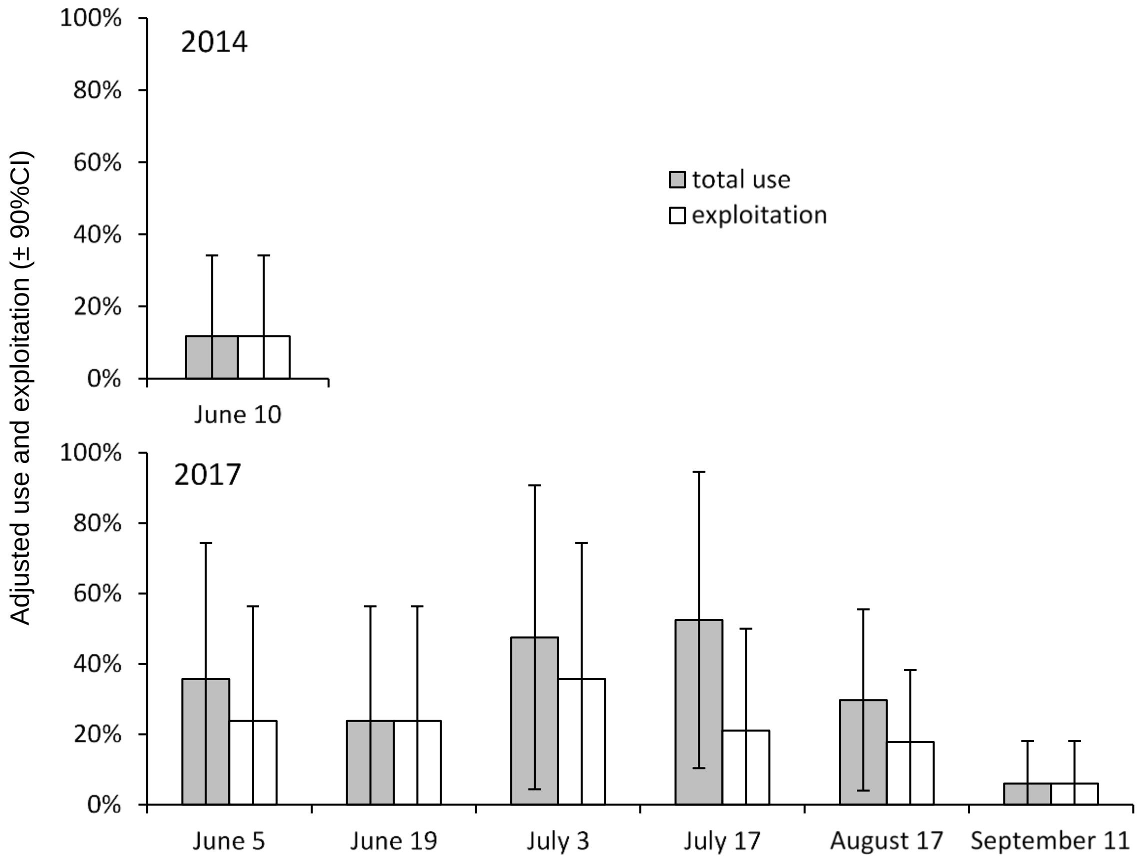

Figure 16. Overall estimated total use (catch) and exploitation (harvest) of catchable Rainbow Trout stocked during select events in Kids Creek Pond in 2014 and 2017.

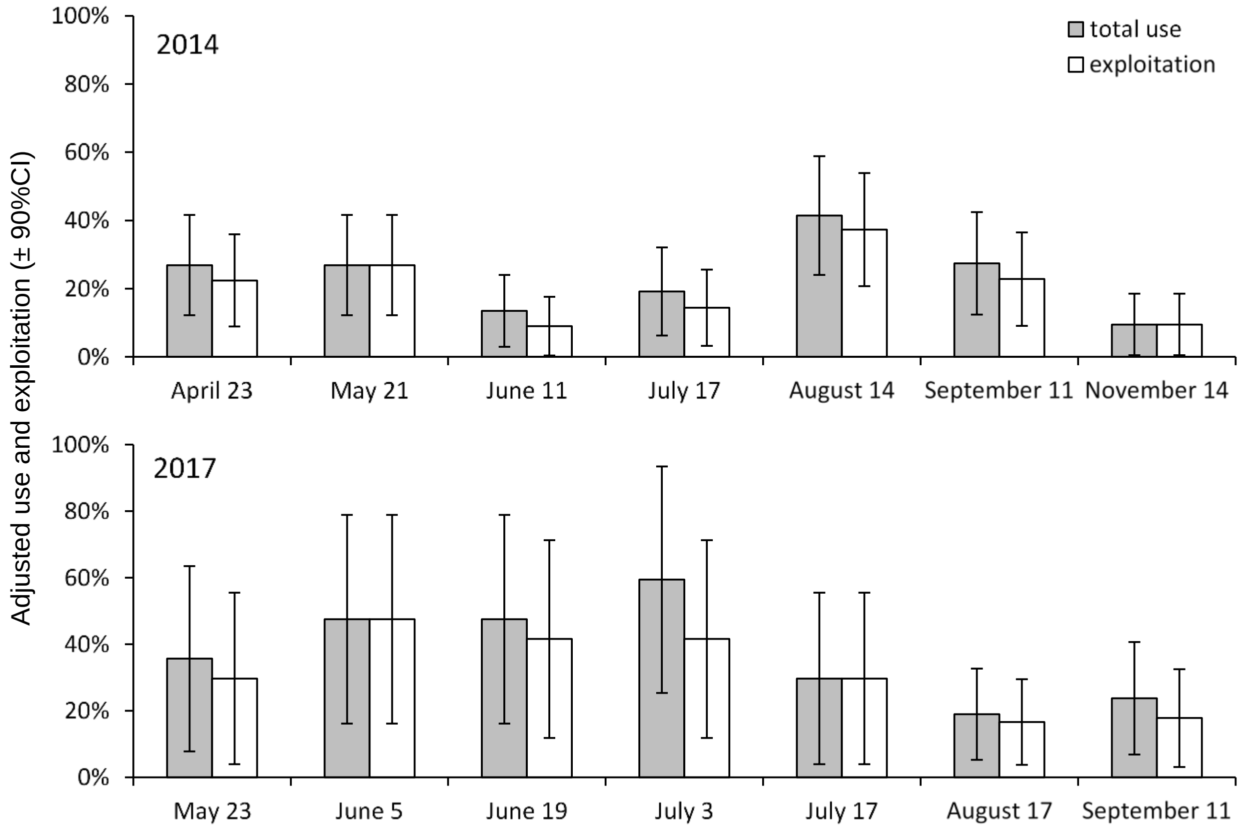

Figure 17. Overall estimated total use (catch) and exploitation (harvest) of catchable Rainbow Trout stocked during select events in Hayden Creek Pond in 2014 and 2017.

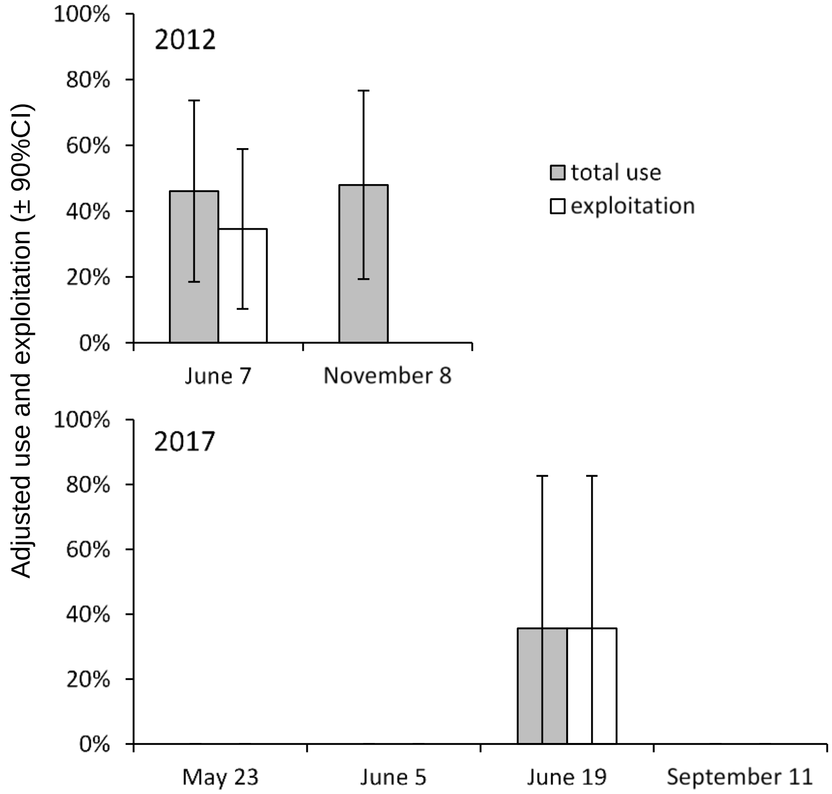

Figure 18. Overall estimated total use (catch) and exploitation (harvest) of catchable Rainbow Trout stocked during select events in Hyde Creek Pond in 2012 and 2017.

WALLACE LAKE REDSIDE SHINER AND TIGER TROUT SAMPLING

ABSTRACT

We have been stocking sterile tiger trout *Salmo trutta x Salvelinus fontinalis* in Wallace Lake annually since 2014 in an attempt to reduce Redside Shiner *Richardsonius balteatus* abundance via predation. Relative abundance of Redside Shiner in Wallace Lake has declined steadily since tiger trout were first stocked. In 2017, mean Redside Shiner relative abundance was 0.89 fish/min in June, 3.03 fish/min in July, and 0.53 fish/min in September, compared to 2.67 fish/min, 3.27 fish/min, and 0.57 fish/min, respectively, in 2016. Although relative shiner abundance has decreased, tiger trout stocked in Wallace Lake seem to be growing very slowly, and we have not encountered large holdover tiger trout in any of our surveys to date.

On June 15, 2017, we set two gill nets (one sinking and one floating) in Wallace Lake to determine size and condition of tiger trout after overwintering in the lake. We caught eight tiger trout in 4.0 h of gill netting (CPUE = 2.0 fish/h) and 19 tiger trout during a combined 10.1 h of angling (CPUE = 1.9 fish/h). All tiger trout captured ranged in length from 256 mm to 401 mm TL, and averaged 321 mm. Although mean TL increased since tiger trout were stocked in June, 2016, mean relative weights decreased from 85 to 65. In late June, 2017, another 1,509 tiger trout were stocked in the lake, ranging from 167 mm to 358 mm TL (mean = 273 mm). Relative weights for tiger trout stocked in June 2017 were similar to the relative weights of tiger trout stocked in June, 2016 (range, 30.5-119.0, mean = 85.3), and were much higher than for fish that overwintered. Another 1,100 tiger trout were stocked in the lake in August, but no measurements were taken on those fish.

Angler effort increased 1.7 times from 2015 to 2016 at Wallace Lake, and effort in 2017 was likely similar to 2016. Remote cameras malfunctioned several times throughout our effort survey period in 2017, and we were only able to collect approximately 1/3 of the sample size (# of photos) we collected in 2015, and 1/2 of the sample size we collected in 2016. Still, estimated angler effort at Wallace Lake from June 15 to September 29 in 2017 was 750 h, compared to 608 h in 2015 and 1,045 h in 2016. Based on tagging data, tiger trout harvest and total use was slightly higher in 2017 than in 2016 (use increased 3.6%, harvest increased 1.2%). However, we believe exploitation and use were underestimated again in 2017, and are likely much higher.

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INTRODUCTION

Wallace Lake is a popular put-and-take trout fishery in the Salmon Region that was first stocked with Rainbow Trout *Oncorhynchus mykiss* in 1968. Wallace Lake has very little to no spawning habitat for salmonids, and thus has been annually stocked with approximately 1,000 to 2,000 catchable Rainbow Trout or Cutthroat Trout *O. clarkii* since 1978.

Redside Shiner *Richardsonius balteatus* were first detected in Wallace Lake in the mid 2000's, and their abundance increased quickly. By 2005, Redside Shiner made up 92% of the gill net catch composition (Esselman et al. 2007). By 2013, stocked Rainbow and Cutthroat Trout were no longer growing well at Wallace Lake, and we theorized this was in part due to competition for forage with Redside Shiner. In an attempt to reduce shiner abundance, we introduced tiger trout *Salmo trutta x Salvelinus fontinalis* in the lake in 2015.

We have been monitoring size structure and relative abundance of the Redside Shiner community in Wallace Lake since 2014, before tiger trout stocking began, to determine whether tiger trout are an effective predator on shiners in the lake. Additionally, we have been monitoring angler effort since tiger trout were stocked in 2015 to determine how the introduction of tiger trout has affected the fishery (see Messner et al. 2017 for a review).

OBJECTIVES

1. Quantify and monitor tiger trout growth over time.
2. Monitor Redside Shiner abundance and size structure to determine how they are affected by repeated tiger trout stocking events.
3. Monitor angler effort, catch, and harvest to determine how stocking tiger trout has affected the value and quality of the fishery.

STUDY SITE

Wallace Lake (WGS84 datum: 45.24625ºN, 114.00730ºW) is a small, 3.0 ha lake located approximately 32 km (road distance) from the town of Salmon (10 km straight distance). The lake sits at an elevation of approximately 2,470 meters, and has a maximum depth of approximately 10 meters. This lake has been managed as a put-and-take Rainbow Trout fishery since 1968, and has also received periodic stocking of Cutthroat Trout fry and fingerlings since the mid-1990s. In 2014, we assessed return-to-creel rates on approximately 2,150 stocked catchable Rainbow Trout in the lake. Harvest and catch rates were 15.4% and 22.3%, respectively, (Messner et al. 2016), but fish condition (mean relative weight) was poor, presumably due to competition with the expanding Redside Shiner population in the lake. In June 2015, we stocked 1,795 catchable-size (200 to 370 mm TL) tiger trout to try to reduce abundance of Redside Shiner and increase available forage for stocked catchable Rainbow Trout. Another 1,200 catchable tiger trout were stocked in 2016, and again in 2017.

METHODS

Biological Sampling

Tiger Trout

On June 15, 2017, prior to stocking tiger trout for the year, the existing fish community in Wallace Lake was sampled by deploying one sinking and one floating monofilament gill net (36 m long by 1.8-m deep, and composed of six panels of 10.0-, 12.5-, 18.5-, 25.0-, 33.0-, and 38.0-mm mesh) for two h each, to determine relative abundance and condition of fish that survived over winter. Then, on June 23 and June 26, 2017, Mackay Fish Hatchery staff stocked 1,509 catchable size (200 to 370 mm TL) tiger trout in Wallace Lake during two stocking events (759 and 750, respectively). A subsample (~10%, n = 150) of tiger trout from the first stocking event were weighed (g), measured (mm TL), and tagged with FLOY t-bar anchor tags to estimate return-to-creel rates, using the Tag-You're-It program methodology (Cassinelli 2015). Another 1,100 catchable tiger trout were stocked in Wallace Lake on August 7, 2017, but no measurements were taken on those fish, and none were tagged for estimating exploitation.

We compared body condition for tiger trout captured during different sampling events using relative weights (W_r), as detailed in Messner et al. 2017.

Redside Shiners

Minnow trapping methods for Redside Shiner in 2017 followed the same methods outlined in the 2014 IDFG Salmon Region Annual Report (Messner et al. 2016). Traps were deployed on June 15, July 26, and September 26, 2017. We used one-way ANOVA (α = 0.05) to test for differences in trap cluster catch-per-unit-effort (CPUE) in 2015, 2016, and 2017 for June, July, and September, then conducted pairwise comparisons using post hoc Tukey's test to determine significant differences in overall CPUE between years and between months.

Angler Effort and Return-to-Creel

We conducted a remote creel survey at Wallace Lake using trail cameras from June 15 to September 29, 2017. Three trail cameras were positioned to photograph the entire lake (Figure 19), and all three cameras were set to take photos at the same time (every hour, on the hour) each day, from 0700 to 2100 h. We downloaded photos once a month and stored them at the regional office. To estimate daily angler effort, we enumerated anglers in each photo and referenced between cameras to make sure no anglers were enumerated twice during any given hour. We then summed the total number of unique anglers, and total number of angler hours observed each day from the three cameras. We grouped estimates into three categories (minimum effort, inferred effort, and maximum effort). Minimum effort was based on counts of individuals who were positively identified as anglers. Inferred effort was based on minimum effort as well as individuals who were likely angling, and maximum effort was a sum of all individuals. We used inferred effort for our reported estimates. Daily counts were summed for each month to arrive at monthly angler effort estimates.

Return-to-creel rates (exploitation and use) were estimated using the methods outlined in Cassinelli et al. (2015) and described in the "Community Ponds Stocking Evaluation" section of this report. Mackay Fish Hatchery staff stocked 1,500 catchable tiger trout in Wallace Lake on

June 23, 2017. Approximately 10% of the stocked fish (*n* = 150) were tagged to estimate return-to-creel. Detailed methods and calculations can be found in Meyer et al. (2010).

RESULTS AND DISCUSSION

Biological Sampling

Prior to stocking in 2017, we caught eight tiger trout in 4.0 h of gill netting (CPUE = 2.0 fish/h) and 19 tiger trout during a combined 10.1 h of angling (CPUE = 1.9 fish/h). All tiger trout captured ranged in length from 256 to 401 mm, and averaged 321 mm (Figure 20). Assuming those tiger trout captured before stocking in 2017 were stocked in 2016, mean TL increased 46.5 mm since they were stocked (Figure 20). However, mean relative weights decreased between June 2016 and June 2017, from 85 (range, 67-99) to 65 (range, 49-88; Figure 20). In June, 2017, we stocked another 1,509 tiger trout in the lake, ranging from 167 to 358 mm (mean = 273 mm; Figure 20). Again, relative weights for tiger trout at the time of stocking were much better than for fish that have been captured after overwintering in the lake (Figure 20). Similar to in 2015 and 2016 (Messner et al. 2017), tiger trout were very healthy and active upon stocking, and we observed them chasing and feeding on groups of Redside Shiner.

Although tiger trout are experiencing slow growth rates and declining body condition (i.e. relative weights) in Wallace Lake, relative abundance of Redside Shiner has declined annually since tiger trout were first stocked in 2014 (Figure 21). From 2014 to 2016, we found significant decreases in Redside Shiner CPUE in Wallace Lake (Messner et al. 2017), and from 2016 to 2017, overall mean CPUE again showed a significant decline ($F = 31.943$, $df = 2$, $p = 0.01$). Redside Shiner were trapped on three occasions in 2017, following the same methods used in 2015 and 2016. We caught 469 Redside Shiner in June, 1,693 Redside Shiner in July, and 291 Redside Shiner in September, 2017 (Table 8 and Figure 21). Overall CPUE was 0.89 fish/minute in June, 3.03 fish/minute in July, and 0.53 fish/minute in September, 2017 (Table 8). From 2016 to 2017, among months, mean CPUE only showed a significant decrease in June (Tukey's, $p < 0.01$), but overall mean CPUE has continued to decrease every year since monitoring began in 2014 (Figure 21).

Analysis of Redside Shiner CPUE trends suggests abundance has significantly declined since tiger trout stocking began, presumably due to predation. Additionally, length frequency data shows that the relative proportion of Shiner < 80 mm TL sampled in September has declined since 2014 (Figure 22), which is likely an ideal size class for the tiger trout in Wallace Lake to prey upon (Winters 2014). However, since tiger trout growth in the lake has been relatively slow, these results may not be directly related to tiger trout predation. We suspect the observed decrease in CPUE are due to direct tiger trout predation, but may also be partially due to a change in Redside Shiner behavior to avoid predation. We observed a change in Redside Shiner behavior in the lake, where prior to tiger trout introduction they were visible throughout the lake's littoral areas, and after tiger trout introduction they seemed to prefer hiding in covered habitat. However, changes in shiner behavior would be difficult to document.

Another potential cause of slow tiger trout growth and a lack of large holdover fish in the lake may be competition for forage with Redside Shiner. Winters (2014) suggests that sometimes tiger trout do not switch to piscivory until >340 mm TL. If that is the case with tiger trout in Wallace Lake, the majority of tiger trout in the lake may be competing for zooplankton forage with Redside Shiner and other smaller tiger trout. The extent to which tiger trout are utilizing Redside Shiner, zooplankton, or some other sources as a forage base cannot be known without further analysis of tiger trout diets throughout the year. Further investigations should address this diet component.

Angler Effort and Return-to-Creel

Only two of our cameras functioned properly from June 15 to July 7 (cameras 1 and 3), and only one camera functioned properly from July 8 to September 29 (camera 2). Due to camera malfunctions, we surely missed some angler effort during those periods. The estimates should therefore be considered a ‘minimum’ amount of effort. Estimated angler effort at Wallace Lake from June 15 to September 29, 2017 was 750 h (Table 9). Angling effort followed a similar trend as was found in 2015 and 2016, with a peak in July and August (Table 9, Figure 23). Angler effort also seemed to be proportionally higher in the afternoon and evening in 2017 (Figure 24). Estimated angler effort was only 72% of that which was estimated using the same methods in 2016, but due to the low number of samples (photos) obtained in 2017 because of camera malfunctions, we feel that effort was significantly underestimated. In any case, angler effort has certainly increased since the initial year tiger trout were introduced, and that increase in angler effort is likely due to the fact that Wallace Lake is one of the few lakes in Idaho where tiger trout are present. The fishery has presented a unique opportunity for anglers in the Salmon Region, and is growing in popularity.

Of 150 tagged tiger trout, only five were reported as harvested and three as caught and released, so use was only estimated at 10.7%, with 7.5% confidence intervals, and harvest was estimated at 5.9% with 5.5% confidence intervals. Additionally, one tiger trout tagged in 2016 was reported as harvested in 2017, and one was reported as caught and released. Even though the bag limit for tiger trout at Wallace Lake was decreased in 2016, to 2 per day, we believe there is substantially more harvest on tiger trout in the lake than what our data suggest. Effort at Wallace Lake has increased considerably since 2015, when total use for each stocked group was 14.1% and 25.5%, respectively, for an overall average of 20.5% total use across both groups (Messner et al. 2017). Perhaps the novelty of catching a tagged fish has worn off, and anglers are no longer inclined to report tagged fish, knowing there is no monetary reward. If harvest is nearly as low as we have estimated over the past two years, we expect to see larger tiger trout coming out of the fishery after winter holdover, but this hasn’t occurred yet. Overall, anglers that catch tiger trout at Wallace Lake are pleased with the opportunity to catch a new and different species of fish (information obtained from angler comments, J. Cassinelli, IDFG, personal communication), even though those fish are not very large. We would like to see higher growth rates on tiger trout in the lake, but regardless of whether that occurs, the current stocking rates provide quality opportunity with potentially high catch rates on a unique species.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring Redside Shiner abundance, size structure, and condition as they relate to the effects of tiger trout introduction.

2. Continue monitoring tiger trout growth, and stock additional tiger trout in 2018 to supplement the growing fishery.

3. Continue evaluating angler effort in 2018.

Table 8. Summary statistics from Wallace Lake Redside Shiner sampling, 2013-2017, including Redside Shiner sub-sample size (*n*), relative abundance (CPUE), total length statistics (mm), and condition factor (K).

	Total # caught	CPUE (fish/min)	Total length (mm)				Condition factor (K)		
			n	Min	Max	Mean (SE)	Min	Max	Mean (SE)
Aug 2013	101	1.12	101	57	141	86 (1.21)	0.50	1.08	0.77 (0.01)
Jun 2014	647	2.70	480	73	156	93 (0.48)[a]	0.41	1.59	0.88 (0.01)
Aug 2014	178	0.74	178	41	140	83 (1.10)[a]	0.35	1.46	0.82 (0.01)
Sep 2014	1,818	3.30	457	45	149	89 (0.75)[a]	0.44	1.32	0.86 (0.00)
Jun 2015	1,670	3.01	455	57	147	95 (0.75)	0.40	1.16	0.82 (0.00)
Jul 2015	3,107	5.74	450	53	156	94 (0.84)	0.45	2.10	0.82 (0.01)
Sep 2015	666	1.22	371	42	156	91 (1.09)	0.26	1.47	0.82 (0.01)
Jun 2016	1,568	2.67	450	64	149	92 (0.65)	0.39	1.23	0.82 (0.00)
Jul 2016	1,739	3.27	450	55	159	93 (0.71)	0.57	1.20	0.84 (0.00)
Sep 2016	327	0.57	148	49	129	92 (0.87)	0.53	1.31	0.92 (0.01)
Jun 2017	469	0.89	217	64	138	97 (0.77)	0.63	1.18	0.91 (0.00)
Jul 2017	1,693	3.03	450	64	145	94 (0.53)	0.42	1.28	0.85 (0.00)
Sep 2017	291	0.53	153	25	145	94 (1.70)	0.56	1.20	0.88 (0.01)

[a] Standard errors (SE) were reported incorrectly in 2014 management report (Messner et al., 2016)

Table 9. Angler use at Wallace Lake from June 8 to October 26, 2015, June 8 to October 12, 2016, and June 15 to September 29, 2017. Values were estimated using three remote trail cameras positioned around the lake, which captured hourly photos of anglers fishing. In 2016, camera one did not function from June 22 to September 14, and camera three did not function from July 21 to September 14. Only one camera functioned during the entire period in 2017.

	June			July			August			September			October			Total		
	‘15	‘16	‘17	‘15	‘16	‘17	‘15	‘16	‘17	‘15	‘16	‘17	‘15	‘16	‘17	‘15	‘16	‘17
Num of anglers	64	147	98	137	238	247	90	126	93	67	43	56	52	8	NA	410	562	494
Angler hours	87	278	141	195	418	374	122	243	165	126	92	87	78	14	NA	608	1045	750

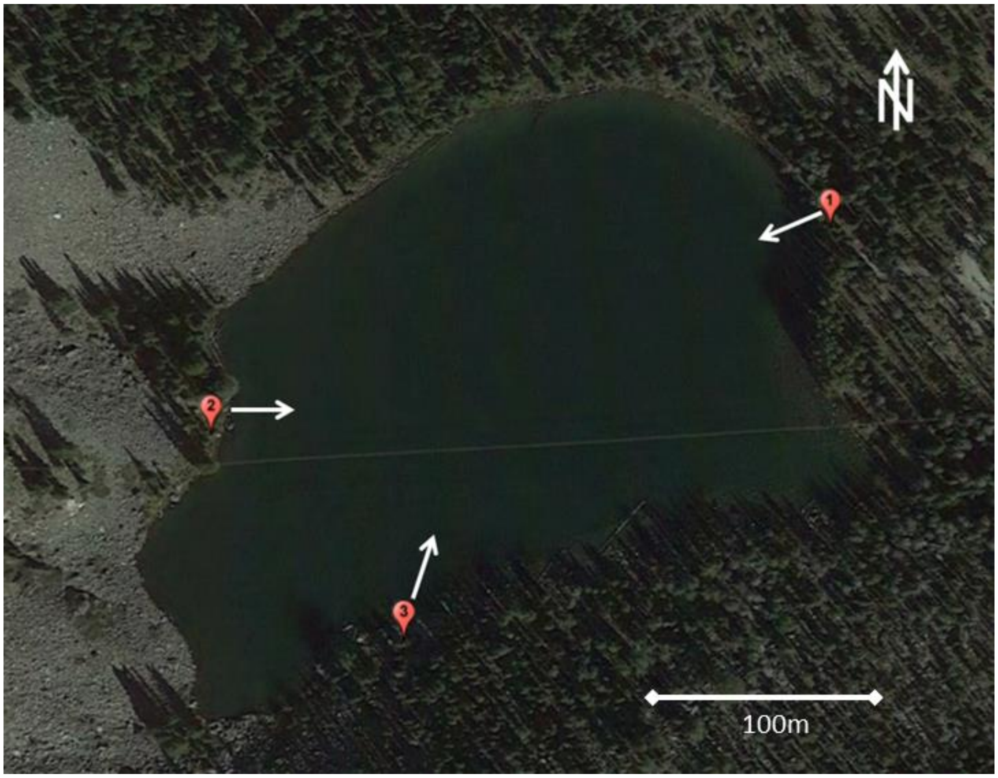

Figure 19. Camera locations and directions of view for estimating angler effort at Wallace Lake, 2015 through 2016.

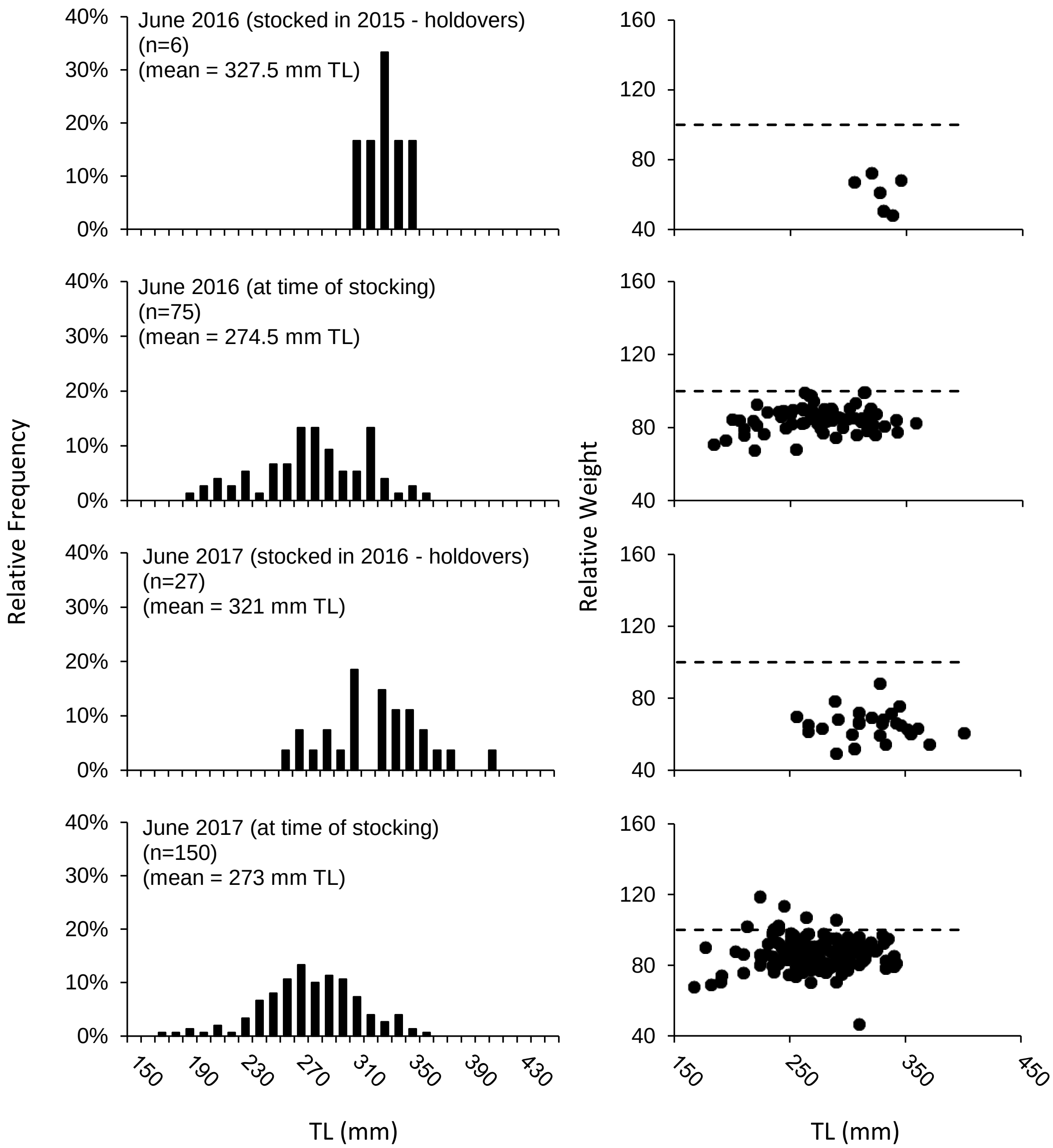

Figure 20. Relative frequencies and relative weights of holdover tiger trout and stocked tiger trout in Wallace Lake in 2016 and 2017.

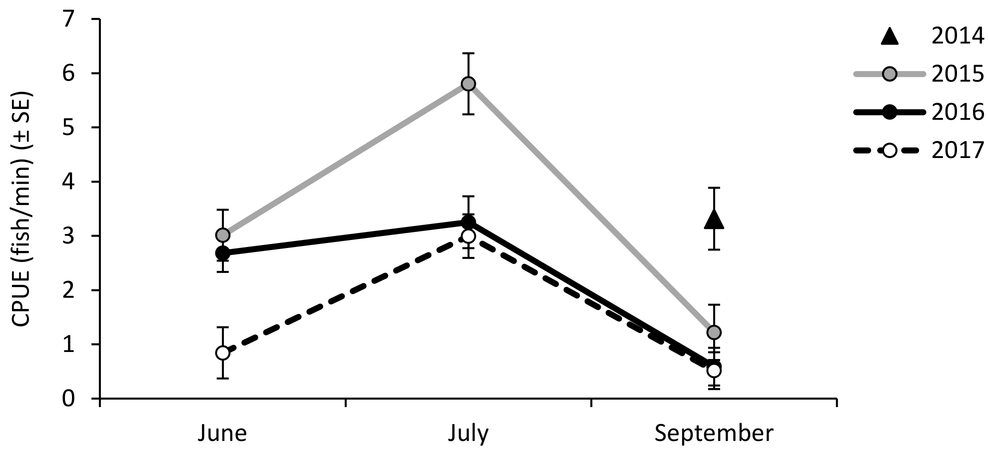

Figure 21. Catch-per-unit-effort (fish/min ± SE) of Redside Shiner captured during minnow trapping in Wallace Lake in June, July, and September 2014-2017.

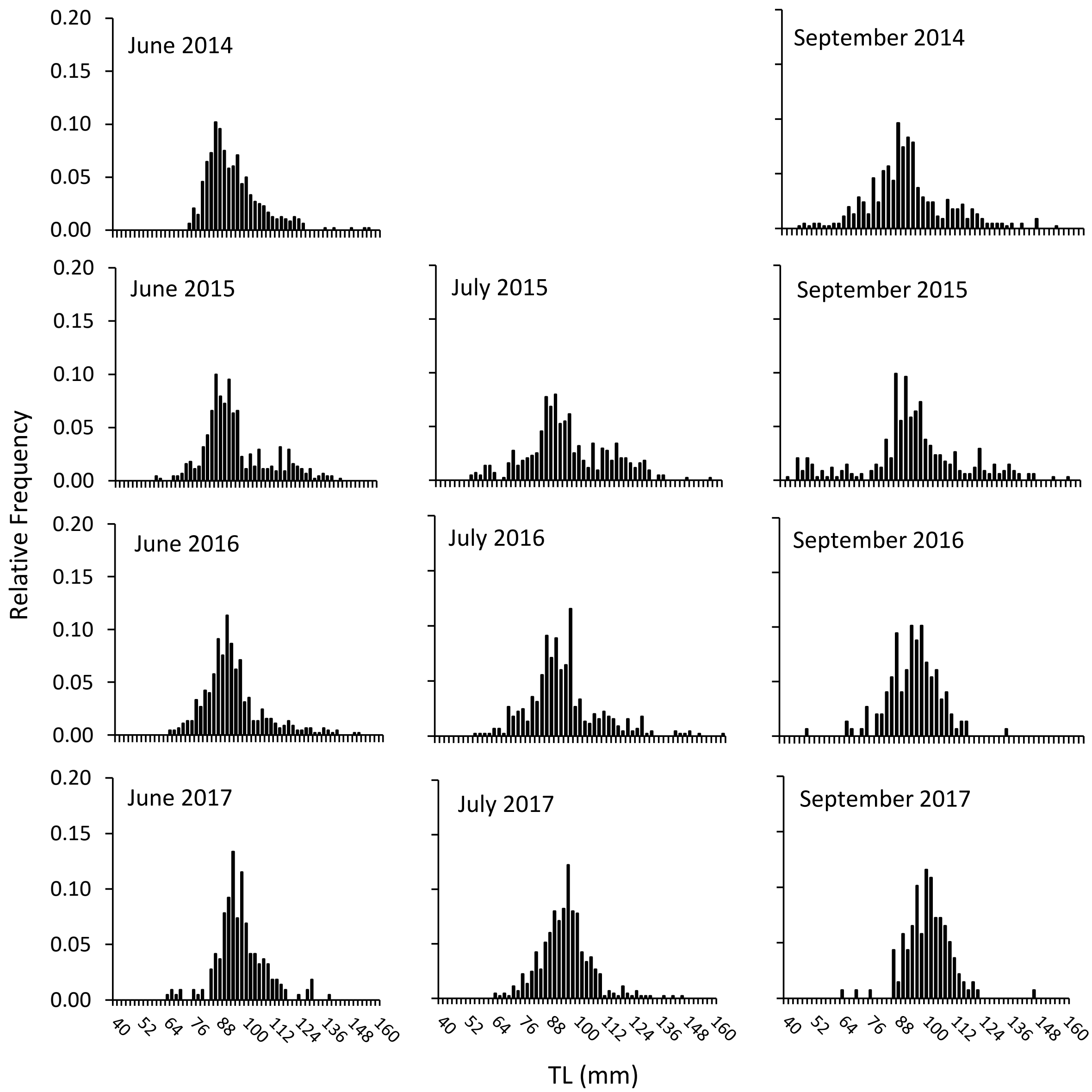

Figure 22. Size structure of the Redside Shiner population in Wallace Lake during sampling efforts from June, 2014 to September, 2017. June 2014 is the only sampling date where only four minnow traps were used, versus the nine clusters of three traps used for all other periods.

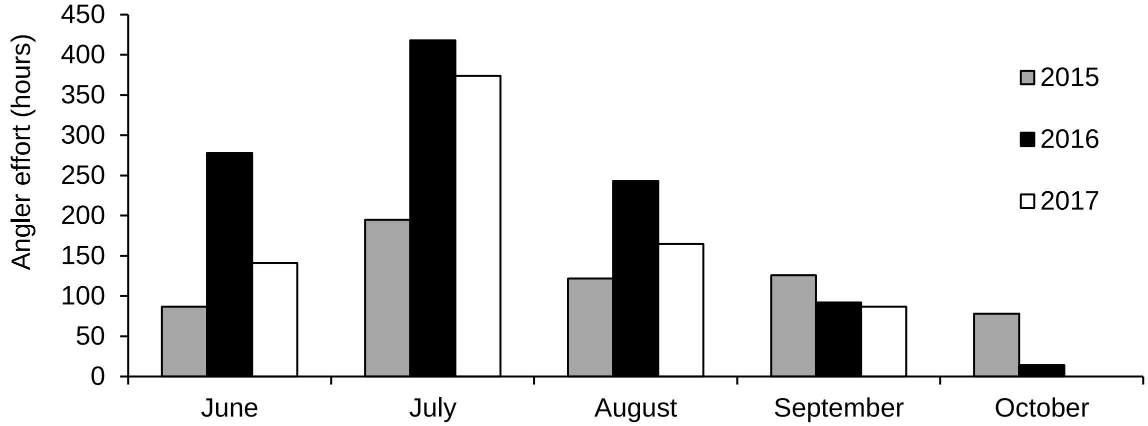

Figure 23. Minimum monthly angler effort at Wallace Lake, 6/8 through 10/26, 2015, 6/8 through 10/12, 2016, and 6/15 through 9/29, 2017.

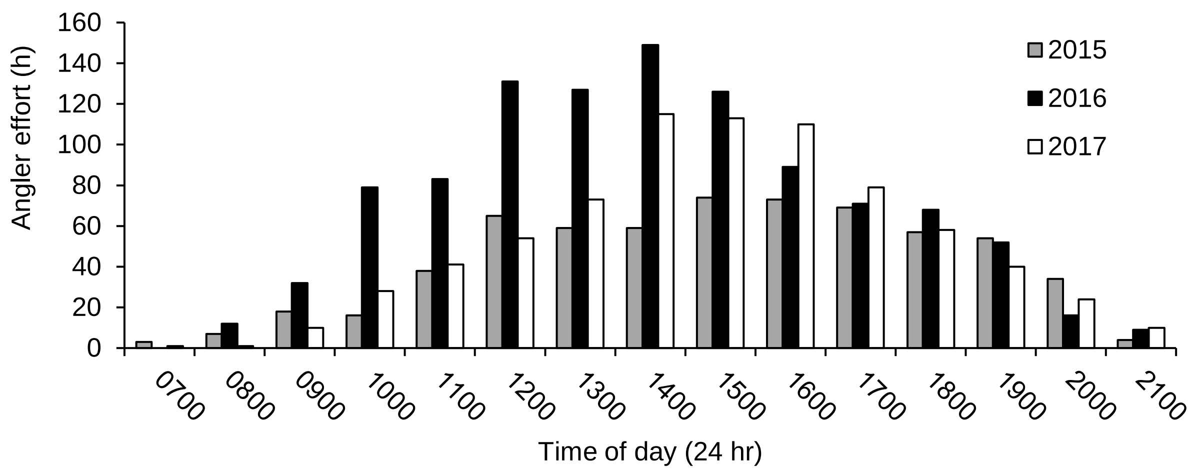

Figure 24. Angler effort by time of day at Wallace Lake 6/8 through 10/26, 2015, 6/8 through 10/12, 2016, and 6/15 through 9/29, 2017.

LAKE INVENTORIES

ABSTRACT

We surveyed the Bayhorse Lakes, Mosquito Flat Reservoir, Grouse Creek Lake, and Quake Lake in 2017 to determine fish composition, relative abundance, and size structure.

Westslope Cutthroat Trout *Oncorhynchus clarkii* fingerlings were stocked in both Big and Little Bayhorse lakes in 2015, and we wanted to determine survival and growth by sampling these lakes in 2017. Rainbow Trout *O. mykiss* were the only species of fish caught in Big Bayhorse Lake in 2017, but Rainbow Trout and Westslope Cutthroat Trout were both caught in Little Bayhorse Lake. These results show that overwinter survival is possible, but suggest Westslope Cutthroat Trout have not grown large enough yet in these lakes to fully recruit to our nets. These lakes will be re-sampled in 2018.

Kokanee salmon *O. nerka* were first stocked in Mosquito Flat Reservoir in 2016, and we wanted to determine if they had survived overwinter and into 2017. We captured Rainbow Trout, Brook Trout *Salvelinus fontinalis*, and one kokanee salmon in the reservoir in 2017. We believe kokanee may not have fully recruited to our gill nets yet, as the one kokanee we caught was under 200 mm TL. However, this finding does suggest some overwinter survival into 2017. Mosquito Flat Reservoir will be re-sampled in 2018 to determine the effectiveness of kokanee stocking.

Quake Lake and Grouse Creek Lake were not gill-netted in 2017, but were visually surveyed to determine whether they should be added to the stocking schedule. We determined Quake Lake is likely fishless, but should support fish if they were stocked. Grouse Creek Lake was deemed too shallow to support overwintering fish.

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INTRODUCTION

The Salmon Region defines lowland lakes as being generally accessible by road and able to be stocked with fish by truck. There are 23 lowland lakes, two reservoirs, and 11 public ponds in the Salmon Region (Curet et al. 2011). Fisheries management objectives for lowland lakes in the Salmon Region focus on providing diverse angling opportunities (i.e. species diversity), with angling catch rates above 1 fish/h, and diverse size structure, including opportunity for trophy-size fish when possible. Understanding fish composition, relative abundance, and size structure is an important part of managing these fisheries, and helps us prioritize management efforts where they are most likely to provide benefit to anglers.

OBJECTIVES

1. Evaluate growth of Westslope Cutthroat *Oncorhynchus clarkii* fingerlings stocked in Big and Little Bayhorse Lakes in September, 2015.

2. Evaluate growth of sterile kokanee salmon *O. nerka* fingerlings stocked in Mosquito Flat Reservoir in June, 2016.

3. Conduct depth profiles and fish species inventories of Quake Lake and Grouse Creek Lake, to determine whether they could be added to the regional stocking rotation.

STUDY AREAS AND METHODS

Bayhorse Lakes

Big Bayhorse Lake (WGS84 datum: 44.41307ºN, -114.40231ºW) is 7.5 ha in size and sits at 2,621 m in elevation in the Bayhorse Creek drainage (tributary of the Salmon River) south of Challis. Little Bayhorse Lake (WGS84 datum: 44.41245ºN, -114.39004ºW) is 6.5 ha and sits 1km to the east of Big Bayhorse Lake, at an elevation of 2,541 m. From Challis, the drive to Bayhorse Lakes is approximately 30 km in total; the last 12 km of which are on a narrow, steep dirt road that winds past the ghost town of Bayhorse (now a state park). While Little Bayhorse Lake offers dispersed camping only, Big Bayhorse Lake has a Forest Service maintained 11-site campground with vault-toilets, picnic tables, and fire rings. Although boating on the Bayhorse Lakes is restricted to non-motorized use only, there is a boat ramp and boat/fishing docks on both lakes for launching canoes, float tubes, and other non-motorized watercraft.

The earliest recorded stocking event for Big Bayhorse Lake was in 1922, and for Little Bayhorse Lake was in 1957. However, due to the proximity of the lakes to the historic mining town of Bayhorse (established in 1877), it is likely they would have been stocked by local miners prior to those recorded events. Prior to 1962 (when the road was constructed), access to the Bayhorse Lakes was limited to foot and horse traffic only. After the road was constructed, angler use at the Bayhorse Lakes likely increased considerably. According to recorded stocking events, Brook Trout *Salvelinus fontinalis* had been stocked in Big Bayhorse Lake from 1937 to 1955, but stocking since then at both Bayhorse Lakes has been almost exclusively Rainbow Trout *O. mykiss*, with occasional introductions of Cutthroat Trout as well (IDFG – historical stocking database). Currently, Big Bayhorse Lake is stocked with approximately 4,000 catchable Rainbow Trout annually, and Little Bayhorse Lake is stocked with 2,000 catchable Rainbow Trout annually. In addition to planting catchable Rainbow Trout, Big and Little Bayhorse Lakes were each stocked with just over 12,000 Westslope Cutthroat Trout fingerlings in 2015.

In 2017, we set one sinking and one floating standard experimental gill net (46 m x 2 m, with six panels consisting of 19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh) at each lake, overnight, to determine fish species composition and size structure, particularly to determine whether Cutthroat Trout introductions in 2015 were successful and determine growth. We also angled for one hour at Little Bayhorse Lake to capture additional fish. Fish caught were identified to species, enumerated, measured (mm TL), and weighed (g), and otoliths were extracted for ageing. We built length-frequency histograms to describe overall size structure, and relative abundance (catch-per-unit-effort, CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours. Otoliths were prepared and examined using the same methodology as was used for otoliths collected from high mountain lakes in Chapter One of this report.

Mosquito Flat Reservoir

Mosquito Flat Reservoir (WGS84 datum: 44.51902ºN, -114.43566ºW) is located on Challis Creek approximately 20 km from the town of Challis at 2,114 m in elevation. The reservoir was constructed in 1949 and 1950 on Challis Creek as an irrigation reservoir for water users in Challis. The dam is 16.8 m high and 137 m long, and holds 986,784 m^3 (800 acre feet) of water at maximum pool (16.2 surface hectares). The reservoir is a popular local fishery due to its proximity to the city of Challis, and the Salmon-Challis National Forest (SCNF) maintains an 11-site campground and day-use picnic area along the reservoir's east-southeast shore.

In 1988, IDFG estimated angler use at 1,270 angler h per year, from June through August, when the reservoir held water (Lukens and Davis, 1989). The reservoir was typically drained from September to May during those years. It was estimated at the time that if a minimum pool level was maintained in the reservoir throughout the year, the value of the fishery would increase by 50%. In 1984, 28% of the reservoir's volume was donated to IDFG for maintenance of fish populations (Liter and Lukens, 1994). To date, the 28% minimum pool is reserved for fish habitat and survival. This minimum pool represents 273,833 m^3 (222 acre-feet) with a surface area of 8.5 ha. The Mosquito Flat Water Users maintain the other 72% of the reservoir. Since 1984, Mosquito Flat has been stocked with diploid Rainbow Trout from a variety of strains as well as triploid Hayspur (IDFG) and Troutlodge Kamloops Rainbow Trout. Additionally, A-run and B-run steelhead (anadromous *O. mykiss*), Bull Trout *S. confluentus*, and Westslope Cutthroat Trout have also been stocked. Brook Trout have also been documented in the reservoir, having apparently migrated downstream from the Challis Creek Lakes (Liter and Lukens 1994). In the past 10 years, an average of 5,200 catchable-sized sterile Rainbow Trout were stocked annually, and the reservoir is managed as a put-and-take trout fishery.

In 2016, we planted 7,054 triploid kokanee salmon fingerlings in Mosquito Flat Reservoir to determine whether they could help improve the overall quality of the fishery by offering anglers a unique opportunity to fish for this species. An attempt was made to establish a kokanee salmon fishery in the reservoir once prior, in 1995, by transplanting 4,072 fry from Fishhook Creek in the Sawtooth Basin, but that introduction failed (Liter et al. 1997). Kokanee salmon provide important angling opportunities elsewhere in Idaho, but there are currently only a handful of lakes that provide angling opportunity for kokanee salmon in the Salmon Region, all of which are located in the Sawtooth Basin, near Stanley. Establishment of a kokanee salmon fishery in Mosquito Flat Reservoir would provide the only opportunity of its kind for regional anglers outside of the Sawtooth Basin.

In 2017, we set three sinking standard experimental gill nets (46 m x 2 m, with six panels consisting of 19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh) at Mosquito Flat Reservoir, overnight, to determine fish species composition and size structure, particularly to determine whether kokanee salmon introductions in 2016 were successful and how much they have grown. Fish caught in the gill nets were identified to species, enumerated, measured (mm TL), and weighed (g). We built length-frequency histograms to describe overall size structure, and relative abundance (catch-per-unit-effort, CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours.

Quake Lake

Quake Lake (WGS84 datum: 44.38969ºN, -113.93935 ºW) is approximately 0.4 ha in size and sits at 2,234 m in elevation in the Grouse Creek drainage (tributary of the Pahsimeroi River), approximately 26 km southeast of Challis, ID. There is no motorized access to the lake, so staff accessed the lake in 2017 by hiking 2.5 km from Grouse Creek Lake (see site description for Grouse Creek Lake). Quake Lake has only been stocked three times in recorded history (1984, 1994, and 1997), all with Rainbow Trout fingerlings. Surveys conducted in 2002 and 2013 found that Rainbow Trout were present in the lake, suggesting that natural reproduction was occurring.

In 2017, we visited Quake Lake to conduct an angling survey to determine whether fish were present, and we conducted a bathymetric survey to determine the suitability of the lake for future stocking. Three anglers fished the lake for one hour each. The bathymetric survey was conducted using a small packraft, handheld depth sonar (Vexilar LPS1), and handheld GPS. Staff traversed the lake several times to record depths and x,y coordinates, and we constructed a bathymetric map of the lake in ArcMap.

Grouse Creek Lake

Grouse Creek Lake (WGS84 datum: 44.38969ºN, -113.93935 ºW) is approximately 1.5 ha in size and sits at 2,557 m in elevation in the Grouse Creek drainage (tributary of the Pahsimeroi River), approximately 24.5 km southeast of Challis, ID. Grouse Creek Lake is accessed via Lime Creek Road, off Highway 93, south of Challis. Complete driving distance from Challis is approximately 30 km, the latter 13 km of which is a dirt mountain road, and four-wheel drive is recommended. The first recorded stocking event for Grouse Creek Lake was in 1948, with Cutthroat Trout fry. Cutthroat Trout fry were stocked in the lake six times between 1948 and 1964, and Rainbow Trout (both fingerlings and catchables) have been stocked exclusively since then. The last time the lake was stocked was in 2010, with 100 catchable Rainbow Trout. Anecdotal evidence suggests Grouse Creek Lake, at one time, supported excellent growth for stocked Rainbow Trout. During a survey conducted in 2002, staff recorded observations of an abundance of leeches, caddisfly larvae, and gammarus shrimp. However, none of the available survey records (1978 and 2002) show evidence of fish presence.

In 2017, we visited Grouse Creek Lake to determine whether fish were present (angling surveys), and whether lake depth was suitable for future stocking.

RESULTS AND DISCUSSION

Big Bayhorse Lake

We caught 13 Rainbow Trout in 27.25 h of gill netting on July 14, 2017 in Big Bayhorse Lake (CPUE = 0.48 fish/h; Table 10). Rainbow Trout ranged from 244 to 339 mm TL and averaged 289 mm TL (SE ± 7.4; Table 11). Relative weights averaged 78 (range, 57-98; Figure 25), and ages ranged from 2 to 5 years (Figure 26).

Although we did not catch any Westslope Cutthroat Trout in Big Bayhorse Lake in 2017, we cannot conclude that fry stocking in 2015 was unsuccessful. Cutthroat growth may be slow enough in Big Bayhorse Lake that those fish stocked in 2015 are not yet large enough to recruit to our gill net (typically > 200 mm TL). The goal of Cutthroat introductions in 2015 was to provide more diverse angling opportunity and establish a self-sustaining population to supplement angler harvest more than is currently being provided by catchable Rainbow Trout stocking. Although Rainbow Trout size and body condition (relative weight) currently provide quality angling opportunity in Big Bayhorse Lake, diversifying the fish composition and improving catch rates would provide further benefit to anglers, and thereby increase the overall quality of the fishery. Monitoring in 2018 should allow us to definitively determine whether 2015 Cutthroat fry introductions were successful, and help us direct future management of the fishery.

Little Bayhorse Lake

We caught one Westslope Cutthroat Trout and one Rainbow Trout in 22.50 h of gill netting at Little Bayhorse Lake on July 14, 2017 (CPUE = 0.09 fish/h) and we caught an additional five Westslope Cutthroat Trout and two Rainbow Trout during one hour of angling (CPUE = 7.00 fish/h; Table 10). Rainbow Trout caught ranged in TL from 287 mm to 297 mm, and averaged 291 mm (SE ± 3.2*;* Table 11, Figure 25). Westslope Cutthroat Trout caught ranged in TL from 201 to 244 mm, and averaged 221 mm (SE ± 6.0; Figure 25). Relative weights averaged 74 (range, 65-86) and 91 (range, 78-103) for Rainbow Trout and Westslope Cutthroat Trout, respectively (Figure 25). Estimated ages for Rainbow Trout ranged from 3 to 4 years, and all Westslope Cutthroat Trout we captured were age 3 (Figure 26).

The Westslope Cutthroat Trout we caught in 2017 were likely all stocked in the lake in 2015, indicating successful overwinter survival for two years. Surveying this lake over the next several years will be necessary to determine how well fish are growing in the lake, and what proportion of the fishery composition they make up, to conclude whether this stocking strategy is beneficial for anglers.

Mosquito Flat Reservoir

We caught 11 Rainbow Trout, three Brook Trout, and one kokanee salmon in 42.00 h of gill netting (CPUE = 0.36 fish/h) in Mosquito Flat Reservoir on July 11, 2017 (Table 10). We also sampled with angling gear and caught a mixture of 17 Brook Trout and Rainbow Trout in 3.5 combined h (CPUE = 4.85 fish/h; Table 10). Exact species composition was not recorded for fish caught during angling (Table 10). Length of Rainbow Trout ranged from 301 to 353 mm (average 323 mm ± 6.0). Length of Brook Trout ranged from 272 to 301 mm TL with a mean of 288 mm (± 8.5). Length of kokanee was 169 mm (Table 11, Figure 27). Relative weights ranged from 69 to

95 (average = 80) for Rainbow Trout and 70 to 90 (average = 81) for Brook Trout, and was 97 for the kokanee (Figure 27).

Kokanee were stocked in Mosquito Flat Reservoir in June, 2016 at approximately 100 mm TL. The one kokanee we caught in 2017 shows that overwinter survival of kokanee in the reservoir is possible, and that conditions are suitable to promote decent growth (~69 mm per year). Our standard gill nets typically do not encounter many fish below 200 mm, so future sampling will give a better indication as to the rate of survival for stocked kokanee. Kokanee were not stocked in the reservoir in 2017 due to a shortage at Mackay Fish Hatchery, but plans are to continue this stocking until it can be evaluated to determine whether it is effective at establishing a kokanee fishery.

Quake Lake

We fished Quake Lake for a combined 3.0 h on July 12, 2017, and caught no fish. Surveyors noted that there was excellent spawning potential in the lake inlet but did not find any fish presence in the lake, nor the inlet or outlet. The bathymetric survey found average depth was 2.6 m and maximum depth was 5.2 m. Considering Rainbow Trout were found in the lake in 2013, 15 years after it was last stocked in 1997, Quake Lake will likely support fish persistence via natural reproduction. However, stocking is recommended to increase fish abundance and improve opportunity for this fishery. We recommend stocking the lake with Westslope Cutthroat Trout to establish a naturally-reproducing trout population, and surveying again 2-3 years after stocking to evaluate if stocking was successful.

Grouse Creek Lake

Grouse Creek Lake was very shallow when surveyed on July 12, 2017. Maximum depth in the lake was 1.4 m, which is likely not deep enough to support fish over winter. However, similar to 2002, surveyors noted that there was an abundance of aquatic invertebrates in the lake. If lake volume increases in the future, this could provide an opportunity for a put-and-grow fishery where fish may experience excellent growth. Continue periodically monitoring lake volume at Grouse Creek Lake to evaluate potential for stocking catchable Rainbow Trout.

MANAGEMENT RECOMMENDATIONS

1. Re-evaluate Westslope Cutthroat Trout survival and growth in 2018 at the Bayhorse Lakes.

2. Re-evaluate kokanee survival and growth in Mosquito Flat Reservoir in 2018.

3. Stock fingerling Westslope Cutthroat Trout in Quake Lake to attempt to establish a naturally reproducing population there.

Table 10. Catch-per-unit-effort (fish/h) for angling and gill netting surveys at Big Bayhorse and Little Bayhorse lakes, and Mosquito Flat Reservoir in 2017.

Lake	Effort Type	Effort (h)	Number of fish captured	CPUE (fish/hr)
Big Bayhorse	gill net	27.25	13	0.48
Little Bayhorse	gill net	22.50	2	0.09
	angling	1.00	7	7.00
Mosquito Flat Reservoir	gill net	42.00	15	0.36
	angling	3.50	17	4.85

Table 11. Summary statistics (total length [TL] and relative weight [W_r])for fish captured in Big Bayhorse and Little Bayhorse Lakes, and Mosquito Flat Reservoir in 2017.

Lake	Species	Number captured	Mean TL (range) (mm)	Mean W_r (range)
Big Bayhorse Lake	RBT	13	289 (244-339)	78 (57-98)
Little Bayhorse Lake	RBT	3	291 (287-297)	74 (65-86)
	WCT	6	221 (201-244)	91 (78-103)
Mosquito Flat Reservoir	RBT	11	323 (301-353)	80 (69-95)
	BT	3	288 (272-301)	81 (70-90)
	KOK	1	169	97

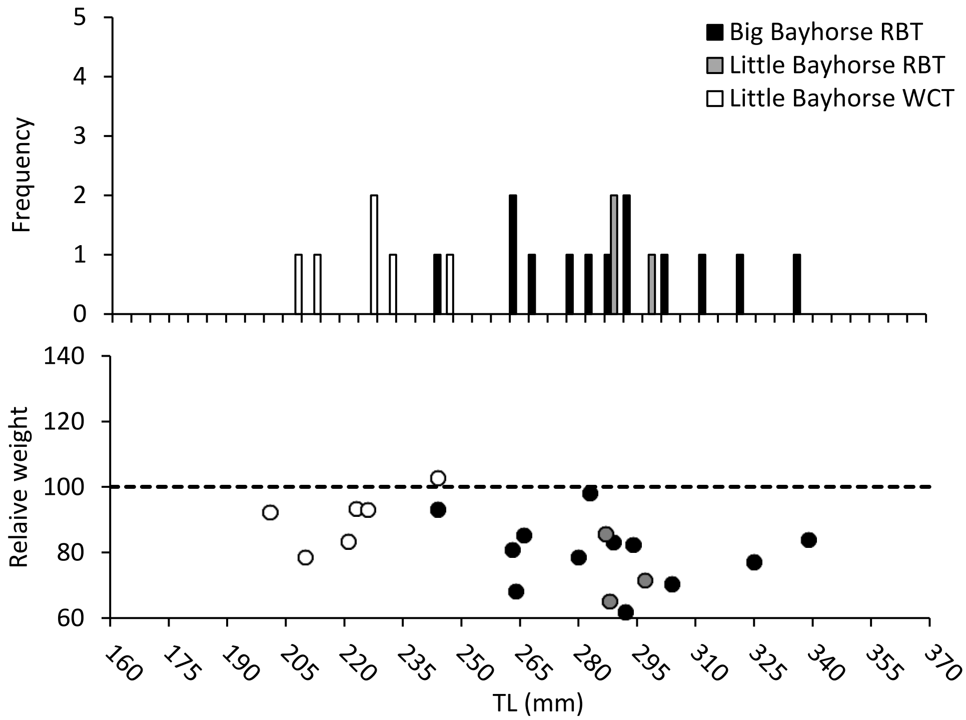

Figure 25. Frequency and relative weight of Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) caught during gill netting and angling surveys at Big Bayhorse and Little Bayhorse lakes in 2017.

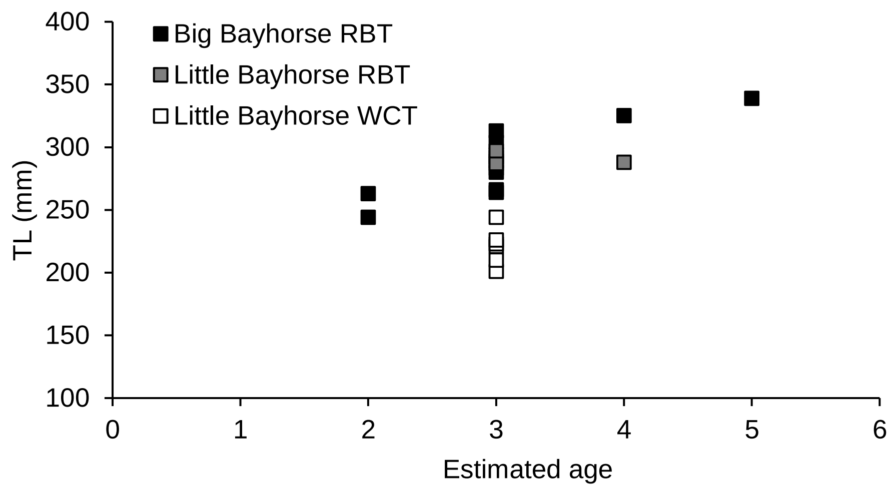

Figure 26. Estimated length-at-age for Rainbow Trout (RBT) and Westslope Cutthroat Trout (WCT) caught during gill netting and angling surveys at Big Bayhorse and Little Bayhorse Lakes in 2017.

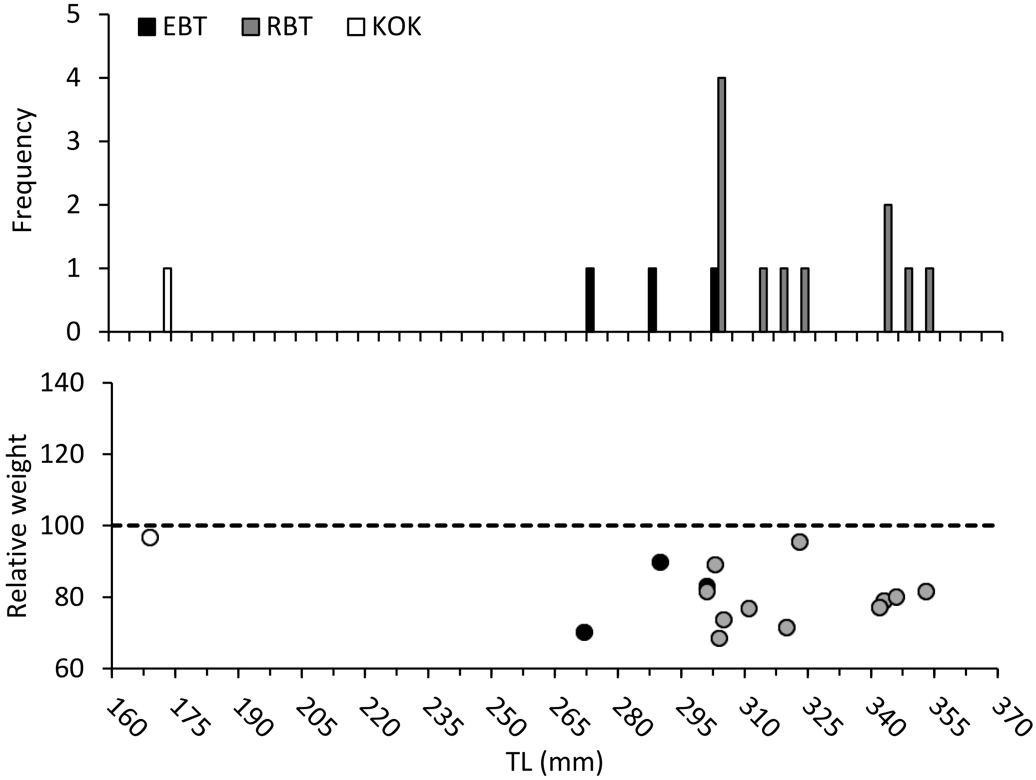

Figure 27. Frequency and relative weight of Brook Trout (BT), Rainbow Trout (RBT), and kokanee (KOK) caught during gill netting at Mosquito Flat Reservoir in 2017.

HELL ROARING AND IMOGENE LAKES

ABSTRACT

We surveyed Hell Roaring and Imogene Lakes in 2017 to determine fish species composition. In 2016, results of an environmental DNA (eDNA) study conducted by the Shoshone-Bannock Tribe and Sawtooth National Recreation Area indicated Lake Trout *Salvelinus namaycush* were present in the Hell Roaring Drainage, above the outlet of Hell Roaring Lake. We did not sample any Lake Trout in our gill netting surveys in 2017. This subject requires further investigation, which will continue during the next several years.

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INTRODUCTION

In 2017, we sampled Hell Roaring and Imogene Lakes in the Sawtooth National Recreation area to determine fish species composition. This survey was prompted by the results of a 2015 eDNA study which suggested that Lake Trout *Salvelinus namaycush* were present in the Hell Roaring Lake drainage, above the Hell Roaring Lake outlet (Carim et al. 2016). The potential for Lake Trout to expand into other Sawtooth Basin Lakes from Stanley Lake, where there is a naturally reproducing population, has become a growing concern in recent years due to Sockeye Salmon *Oncorhynchus nerka* recovery efforts, and the potential threat of Lake Trout in accomplishing recovery objectives (see Stanley Lake section).

A variety of species have been stocked in Imogene and Hell Roaring Lakes since the early 1920s. Records show stocking events for a variety of Rainbow Trout *O. mykiss* strains, Atlantic Salmon *Salmo salar*, Sunapee charr *Salvelinus alpinus oquassa*, and Cutthroat Trout *O. clarkii* in Imogene Lake #1, and Cutthroat Trout, Rainbow Trout, Brook Trout *S. fontinalis*, and Arctic Grayling *Thymallus arcticus* in Hell Roaring Lake. Surveys conducted in 2000 at these lakes found a mixed species composition comprised of Brook Trout, Rainbow Trout, and Cutthroat Trout in both lakes. Although char other than Brook Trout were not detected in the most recent surveys, we suspected eDNA results for Lake Trout may have been a false positive, as a result of the persistence of other char species in the system. Sunapee char in particular, if they are still present in the basin, may influence results as they are closely related to Lake Trout.

OBJECTIVES

1. Construct a bathymetric map of Hell Roaring Lake and Imogene Lake to determine where Lake Trout or Sunapee Trout would likely be found if they occur.

2. Set large gill nets in deep water locations in both lakes to collect char spp. for tissue sampling and genetic analysis.

STUDY SITES

Hell Roaring Lake

Hell Roaring Lake (WGS84 datum: 44.02397°N, -114.93560°W) is approximately 23.1 ha in size, and sits at an elevation of 2,259 m in the Sawtooth Wilderness in the Sawtooth Basin. The lake is very popular with tourism from June through October. There are two trailheads mainly used to access the Hell Roaring Lake basin. The lower trailhead (WGS84 datum: 44.02569°N, -114.84192°W) is primarily used by stock users, as trailers are not allowed on the road to the closer, upper trailhead. Outfitters take clients on fishing and camping trips daily during busy summer months from the lower trailhead, which is approximately 8.9 km to the lake. The upper trailhead (WGS84 datum: 44.02676°N, -114.87762°W) is more popular for hikers, as it is a shorter hike to access the lake (approximately 4.0 km). Due to its popularity, there are somewhere around six to eight established campsites around Hell Roaring Lake that can accommodate large groups. Since Hell Roaring Lake lies within the Sawtooth Wilderness boundary, the campsites are relatively undeveloped.

Hell Roaring Lake was first stocked with Cutthroat Trout fry and Brook Trout fingerlings in the 1940s (IDFG stocking records). IDFG continued stocking Cutthroat Trout fry through the

1950s and 1960s, but were unable to establish a strong trout population, presumably due to high numbers of non-game fish (Redside Shiners *Richardsonius balteatus*, suckers *Catastomus* spp., and Northern Pikeminnow *Ptychocheilus oregonensis*) in the lake. IDFG implemented a restoration effort on Hell Roaring Lake in 1971 by eradicating fish using the antimycin-based piscicide Fintrol, and physically manipulating a small pour-over on the outlet stream to try and prevent future upstream colonization of the lake by non-game fish. Stocking resumed in 1972, and 120,000 Arctic Grayling were stocked between 1972 and 1988. During the next gill netting survey in 1980, technicians reported that there were both naturally reproducing Rainbow Trout and Brook Trout in the lake, and few Grayling and Cutthroat Trout present. Although Grayling and Cutthroat were both stocked through the 1980s and 1990s, Brook Trout and Rainbow Trout remained the dominant species present, likely because of downstream colonization from higher lakes in the basin where those species had been stocked. Kamloops Rainbow Trout were the last fish stocked in the lake in 1999, but did not become established.

Imogene Lake #1

Imogene Lake #1 (WGS84 datum: 44.99643°N, -114.95167°W) is approximately 29.2 ha in size, and sits at an elevation of 2,572 m in the Sawtooth Wilderness, approximately 2.7 km southwest of Hell Roaring Lake. Imogene Lake #1 is just as popular with tourists in the summer months as Hell Roaring Lake. The hiking/stock trail that accesses Hell Roaring Lake climbs another 3.5 km to access Imogene Lake #1. Alternatively, Imogene Lake #1 can be accessed from trailhead at either Yellowbelly Lake or Pettit Lake, both of which access Toxaway Lake, which is only 3.5 km southwest of Imogene Lake #1. There are a large number of established camping areas at Imogene Lake #1 that can accommodate large groups.

The first stocking records we have for Imogene Lake #1 are in the early 1920s, with Rainbow Trout fry (Mount Lassen strain), Sunapee Trout fry, Atlantic Salmon fry, native strain steelhead *O. mykiss* fry, 'silverside shiners' (probably Redside Shiners), and 'smelt eggs' (family *Osmeridae*) stocked between 1923 and 1925. Rodeheffer (1935) surveyed Imogene Lake #1 in August, 1934 and captured only two 'steelhead trout' in a 21 h gill net set. He also noted that 'numerous fingerlings' were captured during night seining, but he was unable to identify them. Recommendations were made by Rodeheffer to construct habitat improvement structures and begin stocking Golden Trout *O. mykiss aguabonita* and more 'native steelhead', but then Cutthroat Trout were stocked exclusively between 1937 and 1967, and Rainbow Trout have been stocked exclusively since then. In a 2000 gill netting survey, Brook Trout, Rainbow Trout, and Westslope Cutthroat Trout were the only species captured. Although there are no stocking records for Brook Trout in the Imogene Lakes basin, it is likely they were stocked in at least one of these lakes sometime prior to 1935. Since 2000, approximately 1,800 Rainbow Trout fry have been stocked every third year, with the most recent being in 2015.

METHODS

Hell Roaring Lake and Imogene Lake #1 were surveyed on August 4 and 5, 2017, respectively. Four head of stock were used to transport sampling gear to the lakes, which included gill nets and floats, mesh bags to hold rocks for gill net weights, rope for setting nets, a handheld depth finder (Vexilar LPS-1) and GPS for collecting data to construct bathymetric maps, labeled DNA vials filled with ETOH, scissors for collecting tissue samples, and an 8ft Highside rubber raft with frame and oars for navigating and sampling the lakes. Bathymetric surveys were conducted first to determine the deepest locations of each lake, and gill nets were set overnight in those locations. Gill nets used for this survey varied in their construction, to increase our chances of catching various species of various sizes, and increase all species detection efficiency. The two gill net types used were 1) a 183-m long x 2-m deep sinking net constructed with 0.4 cm diameter green monofilament, with stretched mesh sections measuring 3.8, 5.1, and 6.4 cm, and 2) standard experimental sinking nets (46 m x 2 m, with six panels consisting of 19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh).

Fish captured in gill nets were identified to species (if possible), measured to the nearest mm (TL), weighed to the nearest g, and a tissue sample was collected and preserved for later genetic analysis of all char species. Additionally, a photo was taken for each char to link phenotypic traits to genetic samples for further evaluation. Genetic analysis was conducted at the IDFG Eagle Fish Genetics Lab to determine the species of each char collected, using mitochondrial DNA sequencing (Matt Campbell, IDFG – personal communication).

Relative weights were calculated for all fish captured using the standard weight formula (W_s):

$$Log_{10}(W_s) = a + b * Log_{10}(\text{total length (mm)})$$

where *a* = the intercept value and *b* = slope derived from Blackwell et al. (2000) (Appendix A), and then converting back to base 10 to solve for W_r:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

RESULTS

Hell Roaring Lake

The bathymetric survey of Hell Roaring Lake determined maximum depth was 18.4 m, and was located in the western portion of the lake near the inlets (Figure 28). Three gill nets (two standard experimental and one 183 m green mono) were set in the deepest portion of the lake overnight for approximately 13.5 h each, for a combined total effort of 40.8 h. In that time, we captured 45 Bull Trout, 19 Brook Trout, 5 Westslope Cutthroat Trout, and 2 Rainbow Trout, for a combined catch-per-unit-effort (CPUE) of 1.74 fish/h (Table 12). Bull Trout length averaged 267 mm TL (range, 202–382 mm), Brook Trout averaged 256 mm TL (range, 128–340 mm), Westslope Cutthroat Trout averaged 362 mm TL (range, 332–395 mm), and Rainbow Trout averaged 325 mm TL (range, 297–352 mm; Table 12, Figure 29). Bull Trout relative weight averaged 97 (range, 80–112), Brook Trout relative weight averaged 84 (range, 78–100), Westslope Cutthroat Trout relative weights averaged 88 (range, 78–98), and Rainbow Trout relative weight averaged 77 (Table 12, Figure 29).

Mitochondrial sequencing found that all char caught in Hell Roaring Lake were either pure Bull Trout or pure Brook Trout. No evidence of hybridization between the two species was found, and no evidence of any other char species was found. Since Hell Roaring Lake was treated with Fintrol in 1971, Bull Trout likely colonized the lake from either the inlet stream or the outlet stream in more recent years. Brook Trout likely colonized Hell Roaring Lake from upstream, either from the inlet stream or from Imogene Lake #1, after the Fintrol Treatment in 1971.

In all previous IDFG gill netting surveys of Hell Roaring Lake, Bull Trout were not encountered. This suggests our sampling in the deepest part of the lake may not represent the actual relative abundance of species in the lake. In addition, the fact that we did not sample the shoreline littoral areas of the lake where most anglers would fish, makes it difficult to interpret this data from a fishery quality standpoint. Brook Trout, Westslope Cutthroat Trout, and Rainbow Trout are likely the most common species that would be encountered by anglers fishing the shoreline of the lake, and all of these species were represented by quality-size individuals (> 300 mm) in our gill net catch. Since the lake has not been stocked since 1999, Brook Trout, Westslope Cutthroat Trout, and Rainbow Trout in Hell Roaring Lake are either naturally reproducing, or are colonizing the lake from other nearby source populations, or a combination of both.

The fact that Bull Trout and Brook Trout have not hybridized in Hell Roaring Lake over the past 40+ years, which is common in many areas where they coexist, is interesting. Perhaps some differences in spawning behavior and/or timing prevent hybridization from occurring in Hell Roaring Lake.

Imogene Lake #1

A full bathymetric survey was not conducted at Imogene Lake #1 in 2017, but depths were measured throughout the lake to determine the deepest locations. Maximum depth in Imogene Lake #1 was approximately 36.6 m, located northeast of the large island. The southwest portion of the lake, near the inlet, was also very deep (~ 30 m). Two gill nets (one of each type described in the methods section) were set in the deepest location overnight for approximately 16 h each, for a combined total effort of 32.1 h. In that time, we captured 19 Brook Trout and one Rainbow Trout, for a combined CPUE of 0.62 fish/h (Table 13). Brook trout length averaged 237 mm TL (range, 180–311 mm) and the one Rainbow Trout caught measured 262 mm TL (Table 13, Figure 30). Mean relative weight for Brook Trout was 82 (range, 71–99), and Rainbow Trout relative weight was 72 (Table 13, Figure 30).

Mitochondrial sequencing found that all char caught in Imogene Lake #1 were Brook Trout. No evidence of any other char species was found. Although we have no records of Brook Trout being stocked in the Imogene Lakes basin, they are the most abundant species that occur in the deeper portions of Imogene Lake #1. Rainbow Trout (last stocked in 2015) were the only other species we caught in the deep portion of the lake, and were in very low abundance. Since we did not sample near the surface of the lake or in the shallower lake margins, it is possible Rainbow Trout may be in higher abundance there. It is very possible Westslope Cutthroat Trout may also be in Imogene Lake #1 since they are actively stocked in several of the higher Imogene Lakes, which drain into Imogene Lake #1. Because we did not sample the littoral areas of the lake in 2017, it would be difficult to infer any characteristics about how this lake functions as a fishery. When we visited the lake on August 5, 2017, we made contact with several anglers who all reported catching some Rainbow Trout and Brook Trout around the shoreline of the lake. It seems Imogene Lake #1 currently provides a quality backcountry fishing experience for most anglers.

DISCUSSION

No Lake Trout, or any unidentified char species, were captured in either lake in 2017. In order to determine the source of the positive eDNA detections for Lake Trout in the basin, further investigation will be necessary. One of the things we found upon further investigation into the Hell Roaring Lake drainage was that Sunapee Trout, a species endemic to Sunapee Lake in New

Hampshire, were stocked into Imogene Lake #1 in 1925 (IDFG stocking database). Since Sunapee Trout, much like Lake Trout, typically inhabit deeper, colder regions of lakes, it is possible that they have gone undetected for decades due to lack of recruitment to our standard gill nets, which are typically set along lake shorelines. Although Sunapee were not collected in any of our samples in 2017, they may be just as likely to occur in the Hell Roaring drainage as Lake Trout. It is unclear whether the eDNA marker used to test for Lake Trout occurrence in the Hell Roaring drainage would be able to distinguish between Lake Trout and Sunapee Trout, a relatively closely related char. Since Sunapee Trout were extirpated from Sunapee Lake in the mid-1900s (Kircheis et al. 1995), Sunapee tissue samples to compare against the Lake Trout eDNA marker are difficult to obtain. Therefore, in 2018 effort should be made to sample all lakes in the Sawtooth Basin where Sunapee have been stocked in order to attempt to collect tissue for comparison against the Lake Trout eDNA marker.

MANAGEMENT RECOMMENDATIONS

1. Work with Shoshone-Bannock Tribe, Sawtooth National Recreation Area staff, and Rocky Mountain Research genetics lab staff to determine the source of positive eDNA detections for Lake Trout in the Hell Roaring Lake basin.

Table 12. Summary of fish caught during 40.8 h combined effort of gill netting at Hell Roaring Lake on August 4, 2017, including catch-per-unit-effort (CPUE), total length (TL mm), and relative weight (W_r).

Species	# caught	CPUE (fish/h)	Mean TL mm (range)	Mean W_r (range)
Bull Trout	45	1.10	267 (202-382)	97 (80-112)
Brook Trout	19	0.47	256 (128-340)	84 (78-100)
Westslope Cutthroat Trout	5	0.12	362 (332-395)	88 (78-98)
Rainbow Trout	2	0.05	325 (297-352)	77 (77-77)
Total	71	1.74	--	--

Table 13. Summary of fish caught during 32.1 h combined effort of gill netting at Imogene Lake #1 on August 5, 2017, including catch-per-unit-effort (CPUE), total length (TL mm), and relative weight (W_r).

Species	# caught	CPUE (fish/h)	Mean TL mm (range)	Mean W_r (range)
Brook Trout	19	0.59	237 (180-311)	82 (71-99)
Rainbow Trout	1	0.03	262 (--)	72 (--)
Total	20	0.62	--	--

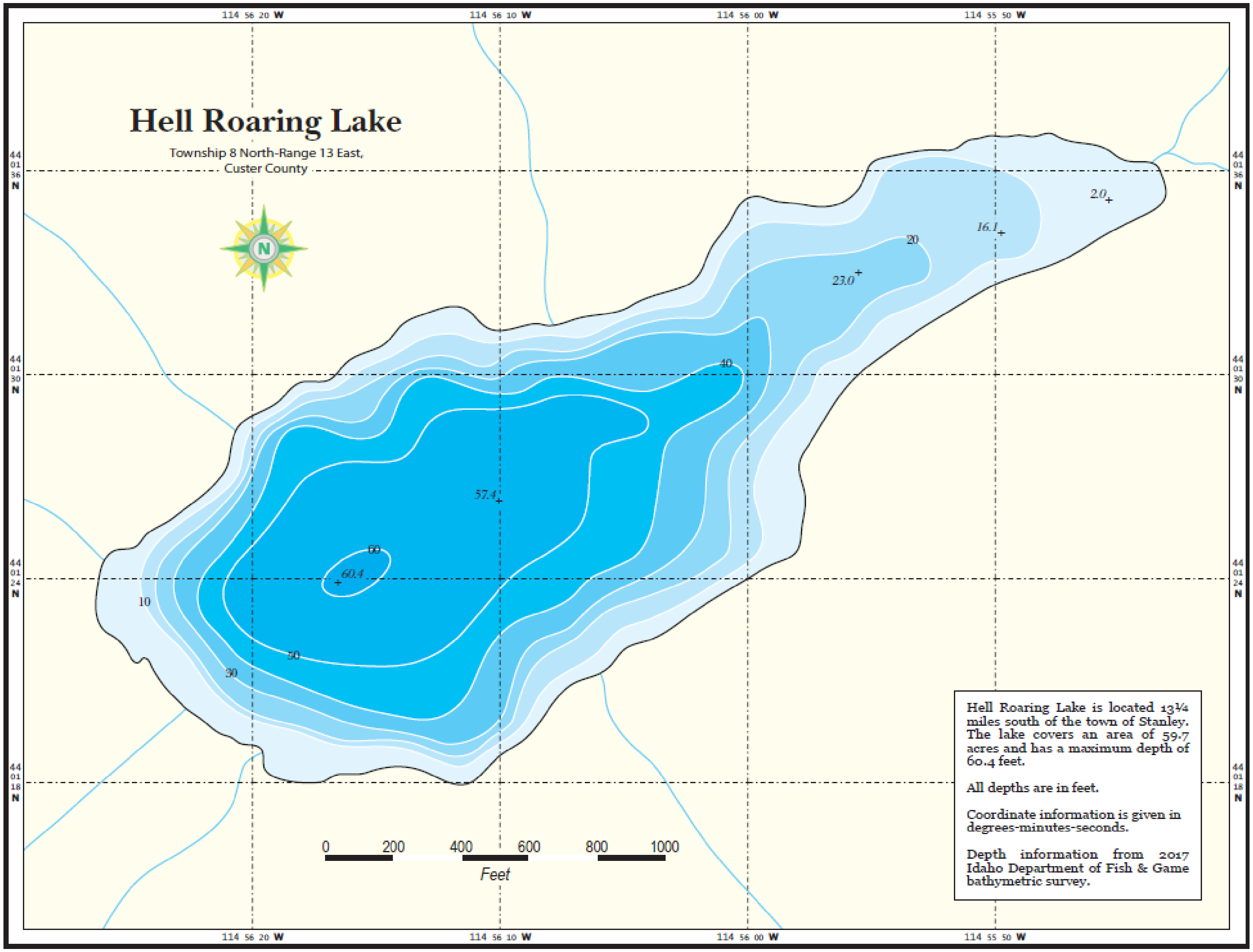

Figure 28. Bathymetric map constructed from depth data and GPS coordinates collected at Hell Roaring Lake on August 4, 2017. All depths are in feet.

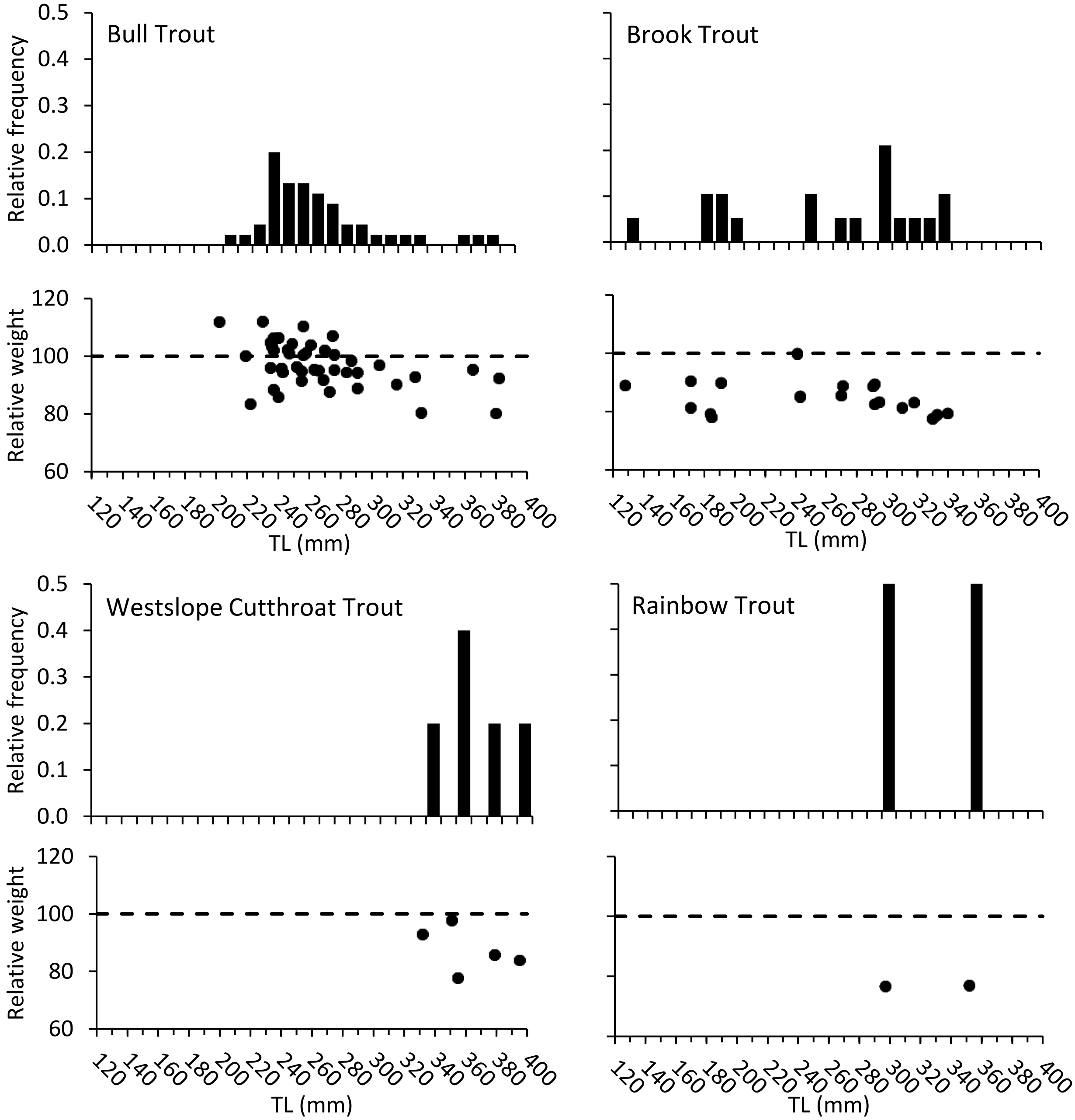

Figure 29. Relative length frequencies and relative weights by total length (TL mm) for Bull Trout (n = 45), Brook Trout (n = 19), Westslope Cutthroat Trout (n = 5), and Rainbow Trout (n = 2) captured during 40.8 h of combined gill netting effort at Hell Roaring Lake on August 4, 2017.

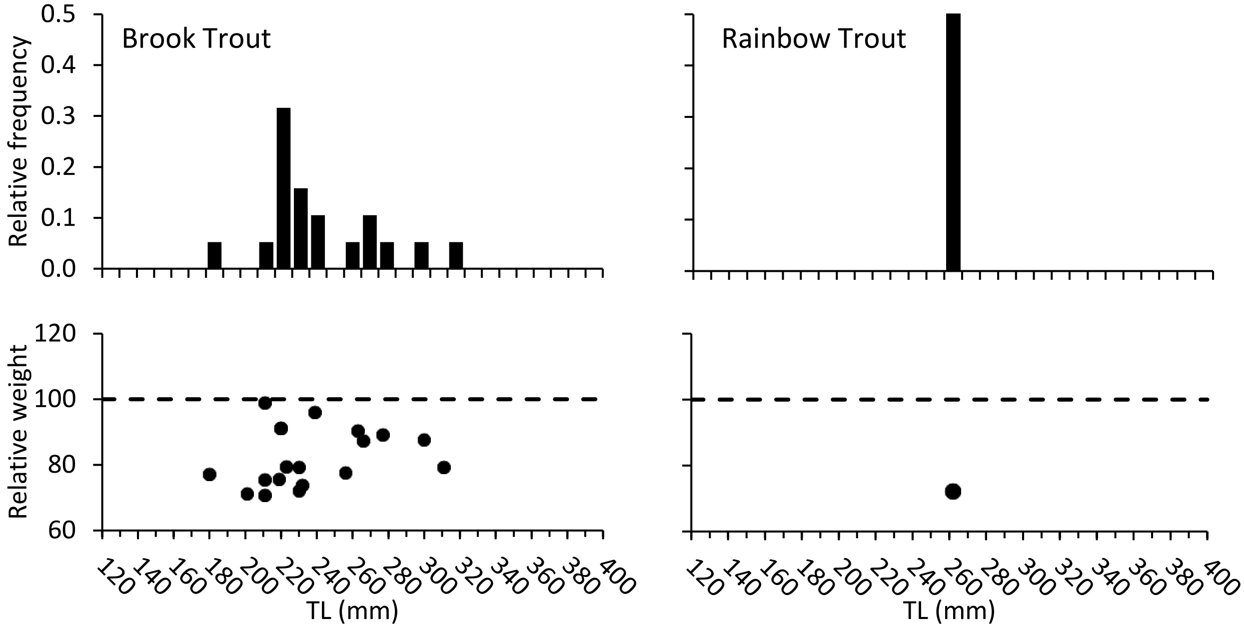

Figure 30. Relative length frequencies and relative weights by total length (TL mm) for Brook Trout (n = 19) and Rainbow Trout (n = 1) captured during 32.1 h of combined gill netting effort at Imogene Lake #1 on August 5, 2017.

STANLEY LAKE

ABSTRACT

We tested the use of specialized gill nets for improving capture efficiency of Lake Trout *Salvelinus namaycush* for future monitoring in Stanley Lake, June 26-29, 2017. Based on CPUE values from 2007 to 2017, the gill nets and method of setting them that were used in 2017 appeared more effective for capturing Lake Trout (especially juvenile Lake Trout (<500 mm TL) than previous gear types and methods used. The nets we used were specifically designed to capture Lake Trout <550 mm TL, which comprised 67% of our sample. Lake Trout captured in 2017 ranged in size from 224 to 904 mm TL (mean length = 470 mm), and relative weights ranged from 69 to 133 (mean 90), similar to in 2012 and 2016. Estimated ages for Lake Trout <550 mm TL captured in 2017 ranged from 5 to 9 years. Mean length-at-age at time of capture for juvenile Lake Trout in 2017 did not differ from those observed in 2012. Relative abundance, body condition (relative weight), and growth of Lake Trout captured in gill nets in Stanley Lake over the past 11 years has remained relatively stable.

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HISTORY AND INTRODUCTION

The earliest reference of Stanley Lake's fishery status and potential was published in a 1935 document written by a temporary biologist working for the Challis National Forest (Rodeheffer 1935). At that time, despite prior attempts to create a sport fishery by planting Brook Trout *Salvelinus fontinalis*, kokanee *Oncorhynchus nerka*, and Rainbow Trout *O. mykiss*, the fish composition in Stanley Lake was primarily non-sport fish (suckers *Catastomus spp*., Northern Pikeminnow *Ptychocheilus oregonensis*, and shiners - likely Redside Shiners *Richardsonius balteatus*). Between 1940 and 1951, IDFG stocked approximately 6,000 catchable Rainbow Trout, 18,000 Cutthroat Trout *O. clarkii* fry, and 400,000 Sockeye Salmon *O. nerka* fry in Stanley Lake to enhance angling opportunity (IDFG stocking database). However, these attempts at establishing sport fish were apparently unsuccessful. Around 1954, Stanley Lake only received an estimated 50 angler days of effort annually (Irving, 1956). By comparison, nearby Redfish and Alturas Lakes received an estimated 3,000 angler days annually at that time.

In September 1954, IDFG launched a major effort to improve the sport fishery at Stanley Lake, which included Toxaphene treatment and construction of an upstream migration barrier at the lake outlet to prevent re-colonization of non-game fish (IDFG Project #F-19-D report, 1954). In 1956, IDFG resumed stocking of hatchery catchable Rainbow Trout (IDFG stocking website), which have been stocked in Stanley Lake annually ever since. After 2000, all Rainbow Trout stocked into Stanley Lake have been sterile. The only other fish that have been stocked in Stanley Lake since 1956 are kokanee fingerlings (1988-1991), Sockeye Salmon fingerlings (1981-1984), and Lake Trout *S. namaycush* fingerlings (1975).

Currently, the Sawtooth Basin is a very popular destination for tourists during summer months. Many lakes in the basin provide angling opportunity, but Stanley Lake now sees the most angler use of all the Sawtooth Basin lakes. In 2011, estimated angler use at Stanley Lake was 12,848 h, compared to 2,816 h at Redfish Lake and 3,348 h at Alturas Lake in 2010 (IDFG unpublished data). As of 2008, Stanley Lake had the 4th highest expenditures of waters in Custer County, generating over $1.9 million in trip-related angler expenditures (Grunder et al. 2008).

Increased interest has developed over the last decade to better understand the dynamics of the Lake Trout population in Stanley Lake. Since 1935, ten gill netting surveys have been conducted at Stanley Lake, seven of which were conducted in the past 11 years (2007, 2010, 2011, 2012, 2015, 2016, and 2017). During all of those gill net surveys, Lake Trout catch rates have been very low (0.05 to 0.27 fish/h). In 2012, over 4,000 gill net h were spent to collect 209 Lake Trout. Most years, Lake Trout catch consisted primarily of large adult fish, so characteristics of immature fish in the lake were largely unknown. However, with the increased effort in 2012, sample size was finally adequate for describing characteristics over a larger range of sizes/ages.

In order to improve our understanding of Lake Trout population dynamics in Stanley Lake, more efficient gear types and methodology are needed to collect larger sample sizes, over a broad range of size classes, with much less effort than was required in 2012. In 2017, we experimented with using specialized gill nets aimed at capturing immature Lake Trout in Stanley Lake, based on mesh sizes and net specifications used for Lake Trout removal on Lake Pend Oreille in northern Idaho. Those results are presented in this report.

OBJECTIVES

1. Determine whether effectiveness of capturing immature Lake Trout (<550 mm TL) in Stanley Lake can be improved with specialized gill nets.

2. Collect otoliths from immature Lake Trout (<550 mm TL) in Stanley Lake for mean length-at-age comparison with those collected in 2012.

3. Tag adult Lake Trout with spaghetti tags to evaluate exploitation and PIT tags to evaluate whether Lake Trout are exiting Stanley Lake/Valley Creek, and entering the upper Salmon River.

STUDY AREAS AND METHODS

Stanley Lake (WGS84 datum: 44.24371ºN, 115.05653ºW) is located in the Sawtooth Basin, near Stanley, Idaho. Stanley Lake is 71.3 ha in size and sits at 1,990 m in elevation. IDFG first stocked the lake in the 1940s, and has been stocking hatchery catchable Rainbow Trout since 1956 (IDFG stocking website). We stocked ~14,000 catchable Rainbow Trout in Stanley Lake in 2014, ~7,000 in 2015, ~9,500 in 2016, and ~8,500 in 2017. The Sawtooth Basin is a popular destination for tourists during summer months, so the lake is managed as a put-and-take fishery for visiting anglers. In addition to stocked Rainbow Trout, there are naturally reproducing kokanee, Brook Trout, Westslope Cutthroat Trout, Bull Trout *S. confluentus*, Lake Trout and Redside Shiner in Stanley Lake. Trout limit is six per person per day, with the exception of Brook Trout (25 per day) and Bull Trout (0 per day, catch-and-release only). We gill netted Stanley Lake from June 26 to June 29 in 2017.

According to gill netting data collected on Lake Pend Oreille in northern Idaho from 2006 to 2016, mesh sizes from 38 mm to 76 mm (stretch mesh) are most effective for capturing immature Lake Trout (<550 mm TL). Based on these data, we contracted Hickey Brothers Fisheries (Bailey's Harbor, WI) to build specialized sinking gill nets for sampling at Stanley Lake in 2017. Each of six sinking nets was 91.5-m long by 2-m deep, and constructed from 3.8 mm diameter light green twine, with three 30.5-m long sections (38-mm, 50.8-mm, and 63.5-mm stretch mesh). We attached pairs of nets together to make three 183 m nets for sampling in 2017. Nets were set in a serpentine pattern in locations determined to be productive for capturing Lake Trout in 2016 (Messner et al. *in press*). We checked nets after the first three hours, on the first day of netting in 2017, to minimize mortality for large adult Lake Trout captured in the nets. After the first three hour sets, we determined that large adult Lake Trout were typically caught by the teeth which did not result in mortalities. From that point forward, we set nets for longer periods ranging 5 to 16 h.

All Lake Trout caught in the gill nets were enumerated, measured (mm TL), and weighed (g), and sex was determined based on external examination of the urogenital region (Mohr 1982). Relative abundance (catch-per-unit-effort: CPUE) was calculated as the total number of Lake Trout caught, divided by the total number of gill net hours. To compare to previous gill net sampling, CPUE was standardized by net area (m^2). Specialized Lake Trout gill nets used in 2017 measured 183 m x 2 m (366 m^2) compared to IDFG's standard experimental nets measuring 46 m x 2 m (92 m^2); therefore CPUE in 2017 was divided by 3.98 (366 m^2/92 m^2 = 3.98) to account for differences in net size and compare between sample years. Relative weight (W_r) was calculated using the same formulas outlined above, with slope and intercept values obtained from Blackwell et al. (2000; Appendix A). For all Lake Trout <550 mm TL, we sacrificed fish and removed otoliths for age and growth analysis. Otoliths were prepared for sectioning at the Salmon regional office, and sectioned and digitized at the Idaho Falls (Region 6) Fish and Game office. Cross-sectioned otoliths were photographed at 40x magnification and read by two independent readers. Discrepancies in age estimates between readers were settled by a third reader. We calculated mean length at age (at capture) for all immature fish sampled in 2017, and compared those results to Lake Trout sampled in 2012.

All adult Lake Trout captured (>550 mm TL) were tagged with orange spaghetti tags bearing instructions for reporting catch and harvest to the Nampa Research Office, Tag-You're-It program. These reports will be used at a later time for evaluation of exploitation and catch of Lake Trout in Stanley Lake. Adult Lake Trout were also given a PIT tag for further evaluation of whether movement occurs past the Valley Creek PIT tag array, and into the upper Salmon River. PIT tags and associated fish information were entered into the Pacific States Marine Fisheries Commission (PSMFC) PIT Tag Information System (PTAGIS [www.ptagis.org]), and alerts were set up to notify regional staff if a Lake Trout is detected crossing the Valley Creek PIT array.

RESULTS AND DISCUSSION

We captured 78 Lake Trout during 210.3 h of gill netting from June 26 to 29, 2017, resulting in a CPUE of 0.37 fish/h. To account for differences in net size and compare to previous sampling events, the standardized CPUE was 0.09 fish/h (Table 14). Lake Trout ranged in size from 224 to 904 mm TL (mean = 470 mm TL; Table 14, Figure 31), and relative weight ranged from 69 to 133 (mean 90), similar to in 2012 and 2016 (Table 14, Figure 32). We captured 52 Lake Trout <550 mm TL (67%) and 26 adults >550 mm TL (33%) in 2017. Otoliths were removed from 52 Lake Trout ranging in size from 224 to 526 mm TL, but two of the samples were mislabeled and therefore discarded. Estimated ages for Lake Trout <550 mm TL captured in 2017 ranged from 5 to 9 years (Figure 33). Of the 26 Lake Trout >550 mm TL we captured in 2017 (560 to 904 mm TL), only one resulted in a mortality. The remaining 25 Lake Trout >550 mm TL were released alive, each with a PIT and orange spaghetti tag.

Relative abundance for Lake Trout captured in gill nets in Stanley Lake has remained very low throughout the past 11 years, ranging from 0.05 to 0.27 fish/h (Table 14). The standardized CPUE in 2017 (to account for net size differences) was similar to what we've observed in previous years, but we were able to improve our overall catch in 2017 using the improved net design and setting methods. Prior to 2017, standard lowland lake experimental gill nets were used for surveys, which were not specifically designed for capturing Lake Trout, and were also very size-biased. Most years, standard experimental nets caught relatively very few Lake Trout <550 mm TL, which made describing characteristics of the entire Lake Trout population difficult. Prior to 2017, the best sample to describe Lake Trout population size structure over the past decade was in 2012, when over 4,000 gill net h were spent to collect 209 Lake Trout (Table 14). In 2017, using gill nets specifically designed for Lake Trout, along with improved methodology (serpentine pattern sets), seemed to improve our capture efficiency for Lake Trout, particularly for targeting juveniles (Table 14). Additionally, size/age structure seemed to be appropriately reflected in our catch this year with highly reduced effort compared to 2012 (210.3 h of net effort in 2017 vs. 4,069.5 in 2012), and the specialized nets we used resulted in low mortality rates for large adult Lake Trout. In future years, if objectives are to get a better representative sample of the Lake Trout population or to capture as many Lake Trout as possible (e.g. Lake Trout removal or tagging efforts) it is recommended to use similar nets and methodology as was used in 2017.

Empirical evidence shows that introduced Lake Trout populations have been very problematic in some lakes in western North America (Martinez et al. 2009). In numerous cases, introduced Lake Trout have displaced native Cutthroat Trout and Bull Trout via predation and competition (Donald and Alger 1993; Ruzycki et al. 2003), which has prompted major restoration efforts costing millions of dollars, annually (Martinez et al. 2009). In Stanley Lake, the concern is not necessarily that Lake Trout will displace native species within Stanley Lake (historical composition of the lake was primarily Northern Pikeminnow, suckers, and Redside Shiner), but rather that Lake Trout will expand into other lakes in the Sawtooth Basin and hamper ongoing native Sockeye Salmon recovery efforts (i.e. Redfish Lake, Alturas Lake, and Pettit Lake).

In general, Lake Trout populations that have expanded their distribution in introduced waters have done so as a result of major shifts in food web composition and dynamics (Martinez et al. 2009). This highlights the importance of monitoring food web structure and abundance in Stanley Lake, which is not currently being done. However, monitoring relative abundance and body condition of the Lake Trout population in Stanley Lake could also help provide insight into whether the population and its food source are relatively stable or not. Our CPUE results suggest the Lake Trout population in Stanley Lake is in fact stable in very low abundance (Table 14), and both body condition (W_r) and mean length-at-age data suggest growth rates have not changed in the past six years (Figures 32 and 33). However, despite stability in the Lake Trout population in Stanley Lake, there is still interest in reducing the risk of expansion and colonization into nearby lakes.

In 2017, the Stanley Lake Advisory Committee was formed to strategize and design a plan for the future of the Lake Trout fishery in Stanley Lake, and develop a formal Stanley Lake Management Plan as part of the statewide IDFG Fisheries Management Plan for 2019-2024. While planning is still ongoing at this time, several discussions have revolved around the concept of converting the Lake Trout population to a sterile (triploid) population. Methods discussed have included gradual reductions in abundance of the local Stanley Lake population and replacement with hatchery-raised juvenile sterile fish, or immediate elimination of the local population followed by sterile fish introductions (both hatchery-raised juveniles and transplanted adults from donor populations). In either case, the results of our surveys over the past several years will be helpful in determining the best gear types, locations, timing, and strategies for targeting and capturing Lake Trout in Stanley Lake for removal if deemed appropriate.

The Stanley Lake Management Plan, when it is complete, will include a monitoring and contingency plan component. This component will be important for documenting whether Lake Trout movement occurs in the Sawtooth Basin, outside of Stanley Lake, and initiating a plan of action if movement is documented. In order to help document such movements, we have PIT-tagged all Lake Trout we have captured and released alive over the past two years at Stanley Lake (n = 48). In order for any Lake Trout to colonize other lakes in the Sawtooth Basin, fish must pass the PIT tag array located on Valley Creek, just above the confluence with the Salmon River. Automatic alerts have been set up to inform regional staff if one of the Lake Trout tags is ever detected crossing the Valley Creek array. To date, none of those tags have been detected.

Continued monitoring and research at Stanley Lake will be necessary in order to develop and implement the most appropriate management strategies. For example, evaluating the feasibility of introducing sterile fish (transplanted or hatchery-raised) will need to occur prior to adopting such a strategy. Additionally, since food web dynamics appear to play a large role in Lake Trout population dynamics, a regular monitoring program should be developed and implemented to develop trends in abundance, size structure, and composition of forage fish in the lake (i.e. all other fish species beside Lake Trout). It is recommended to establish a number of standard monitoring sites that will be surveyed regularly with standard experimental gill nets for a standard amount of time during each survey. Results of such surveys, in combination with continued collection of data regarding Lake Trout community characteristics, will help provide insight into the status of the Lake Trout population in Stanley Lake and its stability.

MANAGEMENT RECOMMENDATIONS

1. Complete the draft Stanley Lake Management Plan.

2. Evaluate the feasibility of transplanting sterile adult Lake Trout from Bear Lake, ID/UT to Stanley Lake, including an evaluation of survival and movement in Stanley Lake.

3. Establish a regular monitoring program for all other fish species (besides Lake Trout) in Stanley, using standard gill nets, to document trends in composition, relative abundance, and size structure.

Table 14. Summary statistics for Lake Trout captured during gill netting surveys at Stanley Lake, 2007 to 2017, including relative abundance (CPUE: fish/h), total length, and relative weights (W_r).

		Lake Trout						
Year	Gill net hrs	*n*	CPUE	Mean TL (mm)	SE TL	Max TL	Mean W_r	SE W_r
2007	164.5	44	0.27	651.2	21.3	930	97.5	4.7
2010	111.5	18	0.16	689.0	42.2	915	94.1	3.6
2011	428.2	37	0.09	679.5	35.5	1017	95.8	2.6
2012	4069.5	203	0.05	551.1	14.5	1005	93.7	2.6
2015	107.6	5	0.05	657.0	114.4	902	95.0	3.9
2016	472.4	38	0.08	606.4	29.2	1083	87.7	1.7
2017	210.3	78	0.09[a]	469.8	20.7	904	89.9	1.2

[a] Raw CPUE for 2017 was 0.37. The value reported above is standardized by gill net area (see methods) for comparison to previous netting efforts.

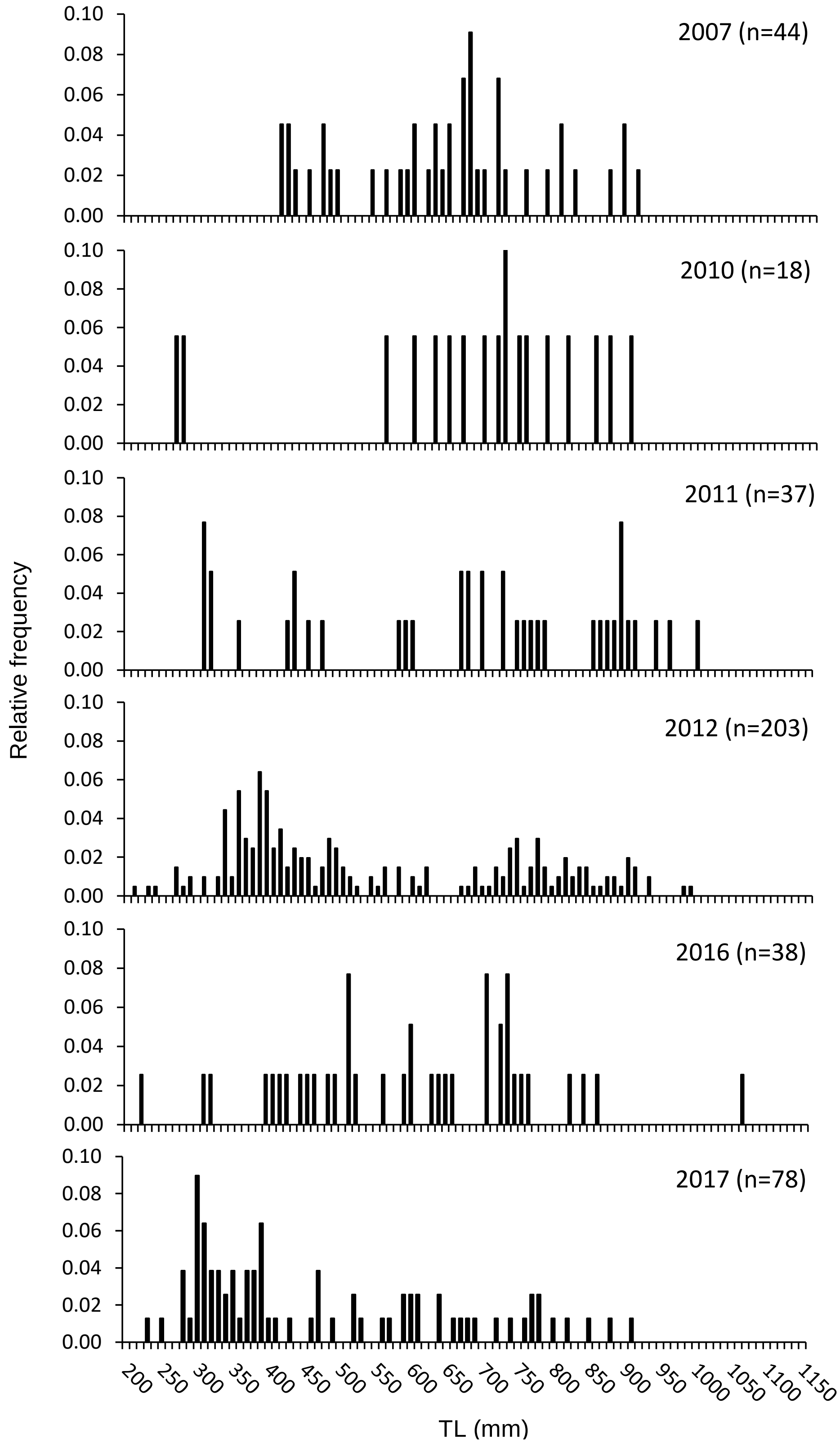

Figure 31. Relative frequency of occurrence of Lake Trout measured in Stanley Lake, 2007 to 2017.

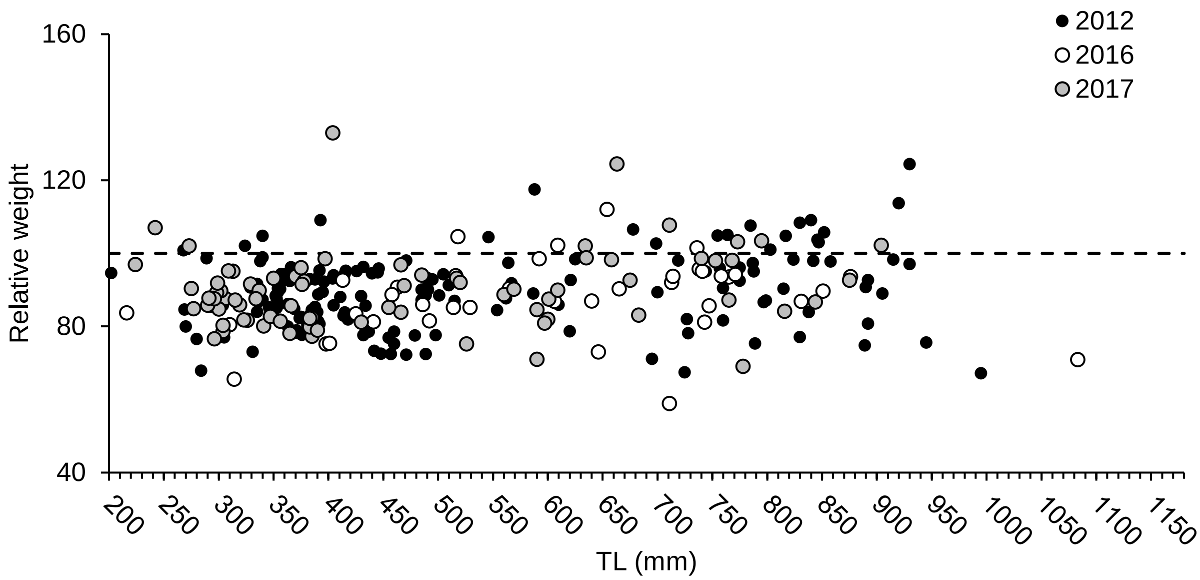

Figure 32. Relative weights of Lake Trout caught in Stanley Lake during gill netting in 2012, 2016, and 2017.

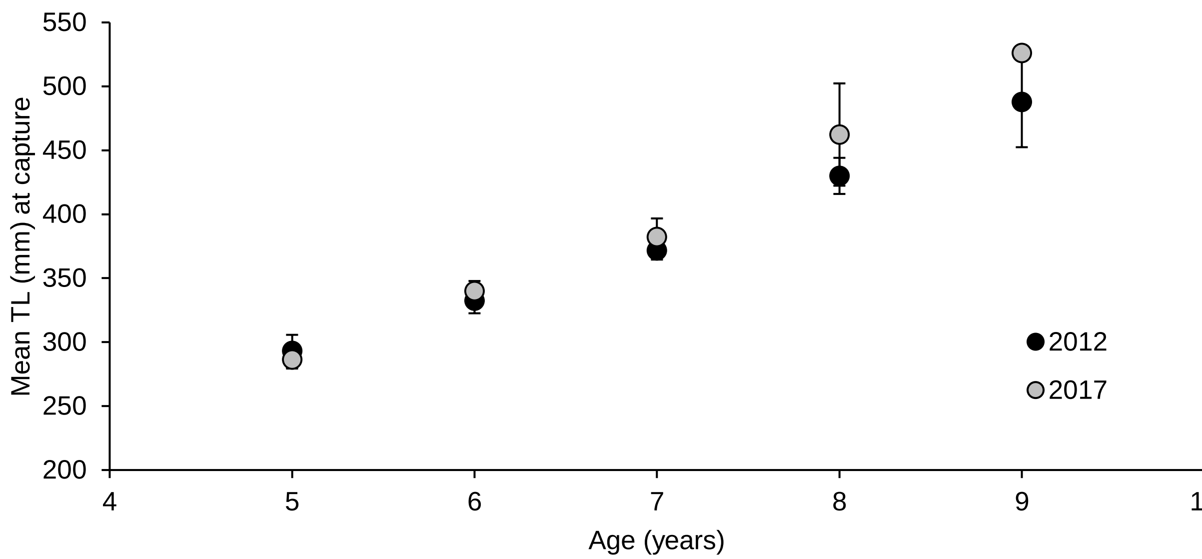

Figure 33. Mean total length (TL) at age, at time of capture for juvenile Lake Trout in Stanley Lake in 2012 (*n* = 47) and 2017 (*n* = 50).

CARLSON LAKE

ABSTRACT

Naturally-reproducing trout populations in high mountain lakes (HMLs) do not always provide desirable sport fisheries. Overabundance can often lead to poor growth rates, which can be improved if abundance is reduced to increase forage availability. In an effort to reduce abundance and improve size structure of an overabundant wild Brook Trout *Salvelinus fontinalis* population in a HML in central Idaho, we stocked tiger muskellunge *Esox lucius x Esox masquinongy* (TM) on three occasions over a 15-year period. Brook Trout abundance was significantly reduced immediately following each stocking event, but increased again 3-4 years following each event. In years when Brook Trout abundance was reduced, size structure improved significantly. From 2002 to 2016, mean Brook Trout TL increased 71 mm, mean relative weight increased from 78 to 95, and proportion of Brook Trout ≥ 250 mm increased from 0.07 to 0.78. In addition to improving Brook Trout size structure, TM showed excellent growth and provided a unique opportunity for anglers to catch trophy-size fish. These results show that, under the right conditions, stocking TM at low density in HMLs with overabundant, stunted trout populations, can improve overall fishery quality.

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OBJECTIVES

1. Monitor Brook Trout abundance and size structure to determine whether tiger muskellunge introduction has been effective at improving the quality of the fishery.

STUDY SITE AND METHODS

Carlson Lake (WGS84 datum: 44.28153ºN, 113.75283ºW) is a subalpine lake approximately 3.5 ha in size located in the Pahsimeroi River drainage at 2,438 m elevation. Subterranean flow from the lake drains into Double Springs Creek, a tributary of the Pahsimeroi River (Upper Salmon River Basin), but there is essentially no outlet and the inlet flow is seasonally intermittent. Carlson Lake has a highly vegetated littoral zone that extends for an average of approximately 12 m from shore and averages around 1 m deep, around the entire perimeter of the lake. Numerous spring upwellings occur in the littoral region of the lake.

TM were reared at IDFG's Hagerman State Fish Hatchery to an average size of approximately 300-330 mm TL, and were stocked in Carlson Lake in June of 2002 (density = 11.7 fish/ha), 2006 (9.1 fish/ha), and 2013 (20.0 fish/ha), following Brook Trout sampling in those years.

The Brook Trout population in Carlson Lake was sampled prior to the introduction of TM in 2002 to collect baseline abundance and size structure information, and periodically (i.e., every 1 to 3 years) throughout the duration of this study (2002 to 2017) to assess their response to TM introductions. Brook Trout were sampled on all occasions using paired floating and sinking experimental gill nets that were 64-m long and 2-m deep, with six different mesh sizes (19-, 25-, 32-, 38-, 51-, and 64-mm bar mesh). Catch-per-unit-effort (CPUE), in units of fish/h of gill net set, was used as an indication of the relative abundance of Brook Trout in the lake.

Prior to gill netting in 2002, 2005, 2013, and 2015, we marked Brook Trout to estimate population abundance using the Peterson mark-recapture method with the Chapman modification (Ricker 1975). We then calculated 95% confidence intervals (CIs) around abundance estimates and examined estimates for CI overlap to detect significant differences.

Brook Trout captured in gill nets during all sampled years were counted, measured (total length to the nearest mm), and weighed (nearest g). All TM captured from 2003 to 2017 were counted and measured, but were only weighed in 2003, 2016, and 2017.

We built length-frequency histograms for Brook Trout each year to examine trends in overall size structure, and calculated the proportion of Brook Trout ≥ 250 mm to describe trends in the relative proportion of "quality size" fish present in the population. Significant changes in the proportion of Brook Trout ≥ 250 mm between years were those in which 95% CIs around the difference between proportions did not overlap zero (Fleiss et al. 1981).

For all fish captured and weighed, we calculated relative weights (W_r) to compare overall change in body condition throughout the study period. Standard weight (W_s) was calculated using intercept and slope values for Brook Trout (*a* = -5.186, *b* = 3.103; Hyatt and Hubert 2001) or TM (*a* = -6.126, *b* = 3.337) (Rogers and Koupal 1997), then W_r was calculated for each fish:

$$Log_{10}(W_S) = a + b * Log_{10}(\text{total length (mm)})$$

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

ANOVA with post hoc Tukey's test for pairwise comparisons was used to test for differences in mean length between years, and relative weight between study years. CIs were calculated for mean relative weights according to methods outlined in Murphy et al. (1990).

Otoliths were removed from a subsample of the Brook Trout caught (about 5 per 10 mm size class) in 2006 and 2015 for age and growth analysis. Ages were also estimated for all captured TM using a combination of otoliths, size at the time of capture, and the presence/absence of PIT tags implanted in all TM stocked in 2013. All otoliths were mounted in epoxy and cross-sectioned using an isometric saw (Beamish 1979). Sections were digitized under 40x magnification and read by two independent readers. If independent readers were not in agreement on an age, a third reader was used to assign an age to the otolith. Using the program Fishery Analyses and Modeling Simulator (Slipke and Maceina 2001), we constructed two age-length keys for Brook Trout (2006 and 2015) in order to determine the proportion of fish of each age, in each length group. Mean length-at-age was then calculated from the age-length keys according to the methods outlined in Murphy and Willis (1996). To estimate growth rates of the Brook Trout populations for each year (2006, 2015, and 2017) we solved for the von Bertalanffy growth parameters (t_0, k, and L_∞), and constructed growth curves for both years, from age-2 to age-7, for comparison, using the equation:

$$L_t = L_\infty \left(1 - e^{-k(t-t_0)}\right)$$

where:
L_∞ = maximum theoretical length (length infinity) that can be attained;
k = growth coefficient;
t = time or age in years;
t_0 = time in years when length would theoretically be equal to zero and;
e = exponent for natural logarithms

RESULTS AND DISCUSSION

We estimated approximately 9,000 age-2 and older Brook Trout (95% CI = 7,474 – 11,064), or 2,570 fish/ha, were in Carlson Lake prior to introducing 40 TM in 2002. One year later, Brook Trout catch rate (CPUE) declined 63%, from 3.69 fish/h to 1.35 fish/h (Table 15, Figure 34). However, abundance began to increase again three years later. CPUE increased to 1.62 fish/h in 2005, and we estimated Brook Trout abundance at approximately 6,100 fish (4,196 – 9,262), or 1,740 fish/ha. CPUE increased again in 2006, to 2.32 fish/h (Table 15, Figure 34), and we decided to stock another 32 TM. After stocking in 2006, Brook Trout CPUE declined again, to 1.62 fish/h in 2009. Abundance may have been reduced even further immediately following stocking, but the lake was not surveyed in 2007 or 2008. Similar to what was observed with the first TM introduction, abundance reductions were not long-lived and CPUE increased again within five years after stocking (to 2.16 fish/h in 2011 and 4.78 fish/h in 2013). By 2013, Brook Trout abundance was estimated at approximately 10,900 fish (9,182 – 13,008), or 3,120 fish/ha, and CPUE was the highest we observed throughout the entire study period (Table 15, Figure 34). We introduced TM again in 2013, at twice the stocking density of previous events (n = 70), and saw a 70% decline in Brook Trout CPUE (to 1.44 fish/h) and another significant reduction in overall abundance to an estimated 2,680 fish (1,653 – 4,748), or 765 fish/ha. Brook Trout CPUE continued to decline to a study period low of 0.81 fish/h in 2016, but again increased in 2017 (2.23 fish/h), four years after the last TM stocking event.

Across the 15-year study period, mean Brook Trout length and proportion of Brook Trout $\geq$ 250 mm were negatively correlated to CPUE (R^2 = 0.49 and 0.31, respectively; Figure 35). Age and growth data collected in 2006 and 2015 suggests that in years of relatively low CPUE (e.g., 2015), the proportion of age-2 and -3 Brook Trout in the lake was much lower than in years when abundance was relatively higher (e.g., 2006). This can be seen in all years immediately following TM stocking events, where younger size/age classes of Brook Trout were nearly absent from our catch (Figure 36). Relative length-frequencies of Brook Trout sampled throughout the study period indicate that TM preyed heavily upon Brook Trout < 180 mm, especially in the first few years immediately following stocking (Figure 36). This likely increased growth rates for remaining Brook Trout that avoided predation (Figure 37), thereby leading to significant improvements in overall size structure (mean TL, mean W_r, and proportion > 250 mm) during the study period. In 2017, age and growth information suggests larger fish that have avoided predation are growing extremely well, reaching sizes that are unprecedented throughout the duration of this study (Figure 37).

ANOVA results showed significant differences in both mean TL (F = 58.5, df = 9, p < 0.01) and mean W_r (F = 200.3, df = 8, p < 0.01) among study years. Both metrics generally improved as abundance declined, and declined with subsequent increases in abundance as mentioned earlier. Mean Brook Trout length increased significantly (p < 0.01) from 2002 to 2005, following the first introduction of TM, but declined again in 2006 (p = 0.06) with an increase in CPUE (Table 15, Figure 34), and an increase in the relative frequency of younger Brook Trout present in our sample (Figure 36). Mean Brook Trout length increased significantly (p < 0.01) again following the second TM introduction, to 234 mm in 2009 (Table 15, Figure 34), and the maximum length observed increased to 312 mm (Table 15). However, by 2013 all size structure metrics once again declined with increases in CPUE (Table 15). With the third stocking event in 2013, a dramatic reduction in Brook Trout abundance resulted in significant improvements to size structure once again (Table 15, Figure 34). Mean Brook Trout length increased significantly (p < 0.01) to 272 mm by 2016, mean relative weight increased significantly (p < 0.01) to 95, and proportion of Brook Trout $\geq$250 mm increased significantly to 0.78, compared to only 0.07 in 2002 (Table 15). By 2017, mean TL and proportion $\geq$250 mm declined as a result of an increase in the relative frequency of smaller, younger Brook Trout in the sample (Table 15, Figures 34 and 36), but maximum TL increased to 397 mm; much higher than anything we had previously observed.

Based on Brook Trout length-frequencies and ageing data collected throughout the study period, TM preyed heavily upon age-3 and younger Brook Trout in the first few years immediately following each stocking event (Figures 36 and 37). Those high predation rates resulted in excellent growth for TM stocked in Carlson Lake throughout the study period, and especially during the first few years after each stocking event (Table 16). Within the first three years in the lake, TM stocked in 2002 grew an average of 144 mm/year, those stocked in 2006 grew an average of 157 mm/year, and those stocked in 2013 grew an average of 125 mm/year (Table 16). Growth slowed slightly after year three for all stocked groups, but body condition remained excellent for all TM captured throughout the course of the study (grand mean W_r = 113; range, 96–135; Table 16). The largest and oldest TM we captured in the lake during the 15-year study period was 1,067 mm at age-12; weight was not measured (Table 16).

Introducing TM in Carlson Lake undoubtedly improved overall fishery quality throughout the study period. Not only did Brook Trout size structure improve as a result of TM reducing their abundance, but excellent growth of TM resulted in a unique opportunity for anglers to catch trophy-size fish. Setting minimum length harvest restrictions for TM at Carlson Lake (none under 1,016 mm) allowed predators to act as biological controls for at least 7 years before being susceptible to harvest, while at the same time providing a trophy catch-and-release fishery. Improvements in Brook Trout size structure would not have been sustained over the long-term without protective regulations and periodic introductions of TM throughout the study period.

Koenig et al. (2015) found that the ability of TM to eradicate Brook Trout was likely a function of habitat suitability and survival after stocking, and that repeated introductions may be necessary in some cases to achieve complete removal. TM stocking in Carlson Lake was able to meet our fishery improvement objectives of abundance reduction without total elimination, likely because (1) low stocking density, (2) the availability of refuge (littoral) habitat for young Brook Trout prevented complete Brook Trout eradication, and (3) additional introductions of TM were made at critical time periods when Brook Trout abundance was increasing. This is especially true of the relative abundance of Brook Trout <180 mm, which seemed to be the preferred size class for predation during the first few years of TM growth.

The methods we used to improve fishery quality at Carlson Lake are likely applicable to other HMLs that contain stunted wild trout populations as well. TM readily consume soft-rayed fusiform prey (Goddard and Redmond 1978), so we believe they would also be effective at reducing abundance of other HML salmonid species. However, individual lake characteristics such as elevation and availability of prey refugia (inlets, outlets, and littoral habitat; Koenig et al. 2015), as well as stocking density, size at the time of stocking, and stocking frequency of TM will likely influence results. It may be a delicate balance to sustain abundance reductions over a long-term period, and continued monitoring of prey responses to predator introductions will help develop prescriptive treatments in these cases to maximize sport fish potential. Continued monitoring at Carlson Lake showed us that stocking TM every four or five years at 10 – 20 fish/ha can continually improve Brook Trout size structure over a long-term period.

MANAGEMENT RECOMMENDATIONS

1. Stock tiger muskellunge in 2018 at low density to maintain improved growth rates for Brook Trout.

2. Collect abundance and size structure information for Brook Trout in Carlson Lake in 2018, prior to stocking tiger muskellunge.

Table 15. Brook Trout relative abundance (CPUE) and size structure (mean TL mm, mean relative weight W_r, and proportion $\geq$ 250 mm TL) throughout the study period (2002 - 2017) at Carlson Lake.

Year	Relative abundance			Size structure		
	Gill net effort (hrs)	# caught	CPUE (fish/h)	Mean TL (range) (mm)	Grand mean W_r (± 95% CI)	Prop $\geq$ 250 mm TL (± 95% CI)
2002	147.8	546	3.69	201 (109-276)	78 (± 0.8)	0.07 (± 0.02)
2003	416.9	562	1.35	209 (96-270)	59 (± 2.3)	0.06 (± 0.03)
2005	369.5	599	1.62	231 (145-290)	89 (± 1.8)	0.48 (± 0.08)
2006	64.8	150	2.32	216 (127-301)	104 (± 2.5)	0.47 (± 0.08)
2009	151.7	246	1.62	234 (136-312)	87 (± 2.0)	0.45 (± 0.07)
2011	132.7	287	2.16	218 (115-291)	80 (± 1.3)	0.26 (± 0.05)
2013	172.5	825	4.78	220 (150-292)	75 (± 0.5)	0.32 (± 0.03)
2015	75.0	108	1.44	252 (165-289)	86 (± 1.5)	0.81 (± 0.08)
2016	82.7	67	0.81	272 (169-351)	95 (± 2.1)	0.78 (± 0.09)
2017	84.2	184	2.23	234 (151-397)	94 (± 1.9)	0.39 (± 0.08)

Table 16. Size structure (mean TL mm and mean relative weight W_r) of tiger muskellunge stocked by year (2002, 2006, and 2013) and sampled at Carlson Lake during the study period (2002 - 2017).

Sample Year	Stocked in 2002			Stocked in 2006			Stocked in 2013		
	n	Mean TL (range) (mm)	Mean W_r (range)	n	Mean TL (range) (mm)	Mean W_r (range)	n	Mean TL (range) (mm)	Mean Wr (range)
2002	32[1]	300 (160-400)	--						
2003	15	531 (460-580)	112 (96-135)						
2005	8	733 (600-813)	--						
2006	4	735 (710-770)	--	40[1]	300 (155-395)	--			
2009	--	--	--	3	770 (770-770)	--			
2013	1	1,067	--	4	899 (863-915)	--	70[1]	333 (290-380)	--
2016	--	--	--	1	910	100	5	708 (647-770)	112 (100-122)
2017	--	--	--	--	--	--	7	795 (750-865)	115 (105-121)

[1]*tiger muskellunge measured at the time of stocking*

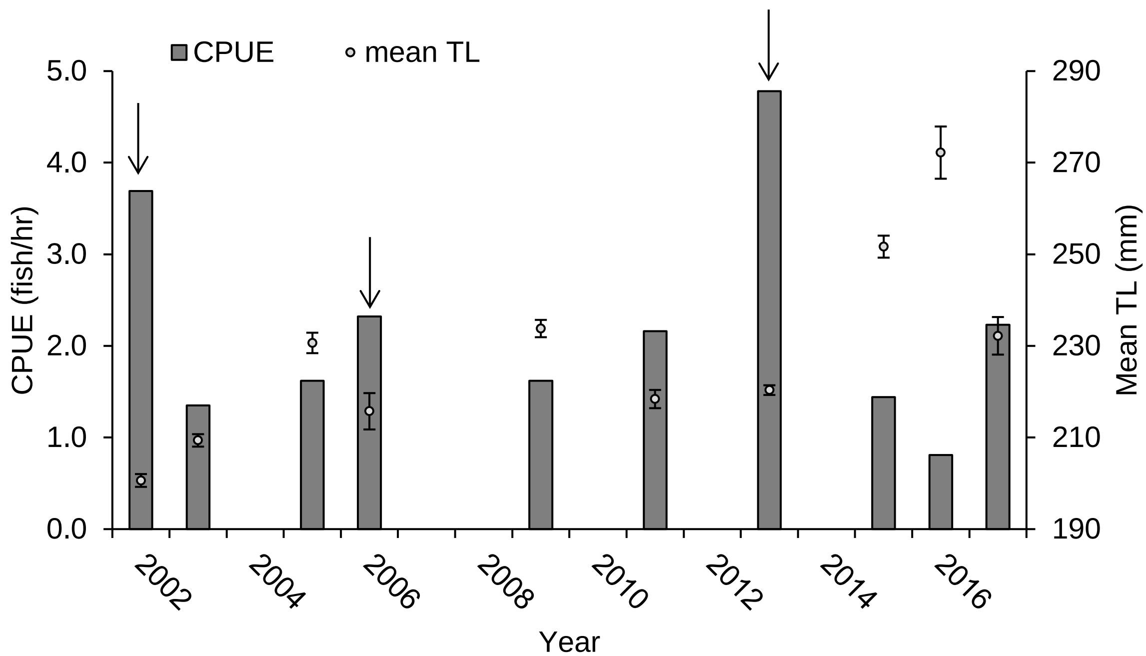

Figure 34. Relative abundance (CPUE, solid bars) and mean TL (mm, open circles; ± 95% CIs) of Brook Trout sampled at Carlson Lake during the study period (2002 - 2017). Arrows denote years when tiger muskellunge were stocked, after Brook Trout were sampled.

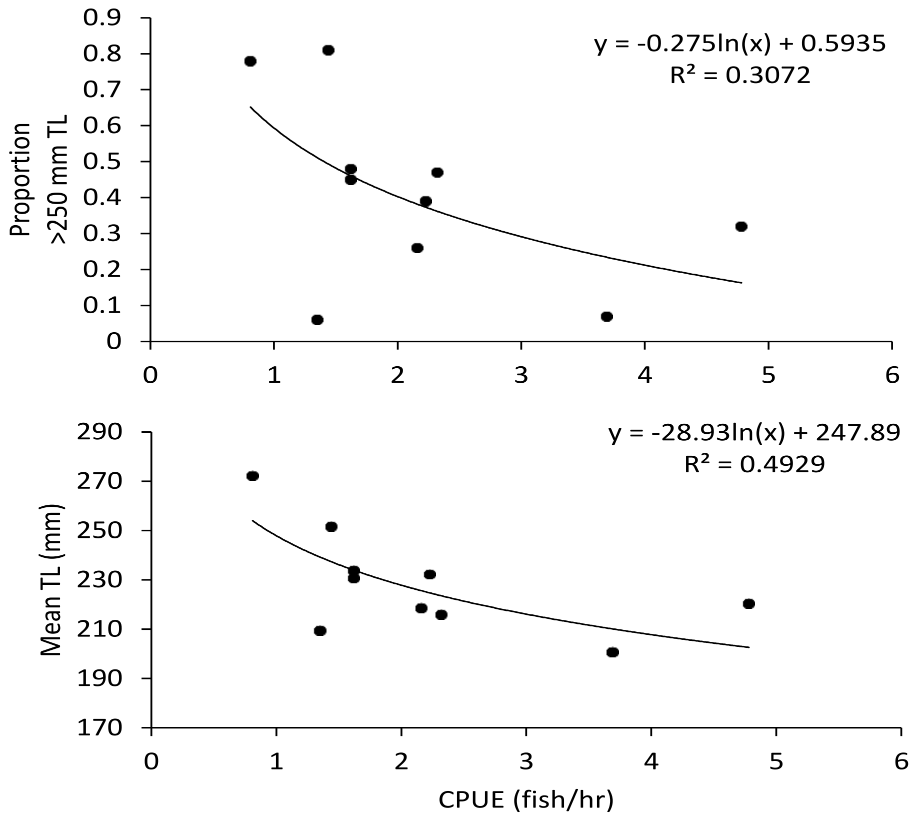

Figure 35. Logarithmic relationships between CPUE (fish/h) and (A) proportion of Brook Trout ≥ 250 mm and (B) mean TL observed during study years (2002 - 2017), at Carlson Lake.

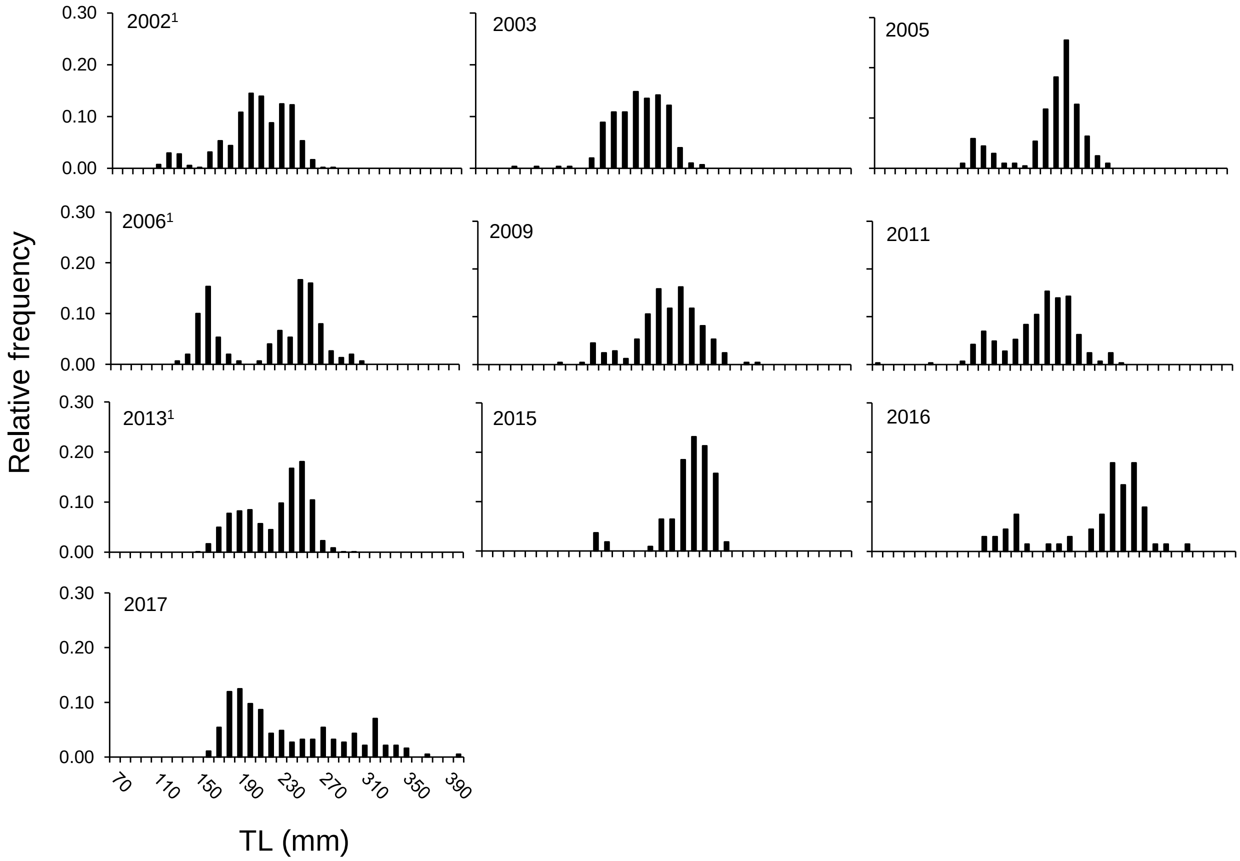

Figure 36. Length-frequency histograms (Total Length TL) of Brook Trout captured in Carlson Lake during the study period (2002 - 2017). [1]Denotes years when tiger muskellunge were stocked, after Brook Trout were sampled.

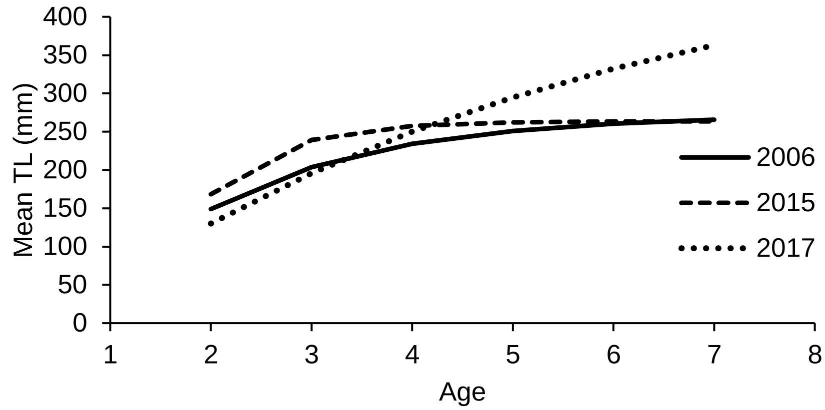

Figure 37. Von Bertalanffy growth curves illustrating differences in Brook Trout growth in Carlson Lake between 2006 (when CPUE was 2.32 fish/h) and 2015 (when CPUE was 36% lower = 1.44 fish/h). Values used to construct growth curves were calculated in FAMS (Slipke and Maceina 2014) (2006: t_0 = 0.652, k = 0.588, and L_∞ = 272.132) and (2015: t_0 = 1.255, k = 1.366, and L_∞ = 270.62).

WILLIAMS LAKE ICE FISHERY

ABSTRACT

We conducted a creel survey on the Williams Lake ice fishery from December 19, 2016 to March 24, 2017 using three automated game cameras positioned around the lake, set to take hourly photos. We counted a minimum of 357 angler h during the survey period, which we consider to be a relatively conservative estimate. Heavy snowfall throughout the winter of 2016/2017 likely contributed to low angler effort this year, relative to most years. Immediately following each period of heavy snowfall this winter, we observed a decrease in angler effort, likely due to access difficulties and relatively poor ice conditions associated with the heavy snowfall. Ice fishing effort this season was higher during the mid-day period (1030 to 1430 h) than during morning and evening hours, and higher on weekends than on weekdays. We conducted 14 angler interviews on four days (two weekdays and two weekend days) and calculated an average weekday catch rate of 1.2 fish per hour (SE ± 0.3) and an average weekend day catch rate of 1.1 fish per hour (± 0.6). Rainbow Trout *Oncorhynchus mykiss* composed 80% of the catch, while the remaining 20% were Bull Trout *Salvelinus confluentus*. Rainbow Trout measured in the creel averaged 394 mm TL (range, 254–457 mm) and Bull Trout averaged 301 mm TL (range, 174–368).

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INTRODUCTION

Williams Lake was formed approximately 8,000 to 10,000 years ago when Lake Creek, the inlet stream, was blocked by a massive landslide (Barnes et al 1994). Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* are the only species that are found in Williams Lake, and are both naturally-occurring and naturally reproducing. However, the current strain of Rainbow Trout found in the lake is likely not the same strain that was naturally-occurring. From 1947 to 1964, the Idaho Department of Fish and Game and US Fish and Wildlife Service jointly operated an egg-taking station on Lake Creek, the inlet to Williams Lake, to collect eggs from the naturally-occurring strain of Rainbow Trout in the lake. Records indicate that each year between 1,000 and 4,000 Rainbow Trout were spawned to collect 800,000 to 3.5 million eggs per year. These eggs were reared to the fingerling stage in rearing ponds located below the outlet/landslide dam at Williams Lake, and a portion was planted back into Williams Lake, while the remainder was used for stocking waters throughout the region.

Prior to 1951, access to Williams Lake was limited to foot and horse traffic only, but in 1951 a toll road was constructed and development began around the privately-owned eastern third of the lake. In the 1960s, a resort and a large number of private residences were built on the lake and the popularity of the fishery grew quickly. Between May and September in 1965, it was estimated that 6,000 anglers fished a total of 25,360 h and harvested a total of 35,466 Rainbow Trout from Williams Lake (Bjornn 1967). Presumably due to increased fishing mortality, biologists observed declines in mean length and mean age of Rainbow Trout from 1952 to 1958 and supplemental stocking of fingerling and catchable Rainbow Trout was initiated in 1964 (Bjornn 1967). In 1968, the US Forest Service built a road to access the western portion of the lake (where there is currently a USFS public boat ramp) to keep up with increasing pressure in the area. The various strains of Rainbow Trout that were stocked in Williams Lake throughout the 1960s and 1970s were not well documented. Over 1.5 million fry and fingerlings were stocked during that time and between 1983 and 1991, and a self-sustaining population became established and stocking was discontinued. Regulations were put in place in the 1980s to reduce harvest on Rainbow Trout and increase their survival. Lake Creek was closed to fishing during the spring to protect spawning fish, and ice fishing was limited to a defined period each year (range, 15-31 d).

The Williams Lake fishery has also faced challenges with water quality over the years. Water quality degradation occurred in the lake from the 1960s to the 1990s, due to the additive effects of cattle grazing and timber harvest in the drainage, and home development and leaching septic systems around the lake shore. Addition of sediments in the lake carrying high concentrations of nutrients accummulated and were stored for several years at a time due to the meromictic nature of Williams Lake (does not fully mix every year). High concentrations of stored nutrients, when released into the epilimnion, resulted in large toxic algae blooms on occasion. In addition, because the lake does not mix every year, water in the hypolimnion becomes anoxic and dilutes the oxygen-rich epilimnion when a turnover occurs, resulting in large fish kills (Barnes et al 1994). The last-documented of these large fish kills was in November 1998 (Curet et al. 2000).

In 1994, a private consulting company (KCM) was contracted to conduct a water quality assessment of Williams Lake and formulate recommendations for restoring and managing the lake's water quality (Barnes et al 1994). Recommendations from the plan included basin-wide enforcement of "best management practices" for managing riparian zones, roaded areas, forestry activities, and agriculture. It also included watershed control measures in the developed area of the lake including septic system improvements, improved construction practices, landscaping techniques, and drainage controls. Further, the study recommended construction of a stratifiedcirculation system in the lake for operation between October and May to increase oxygen concentrations and promote continual mixing of the water column. Costs associated with this option were estimated at approximately $600,000, and were not considered feasible.

Throughout the 2000s, there was a reduction in both fish survival and fish harvested from Williams Lake, which was believed to be a result of reductions in dissolved oxygen concentrations in the lake. For example, winter dissolved oxygen concentrations during that time would typically fall below 5 mg/l within 2-4 m of the surface, and in summer dissolved oxygen concentrations of 1 mg/l occur as shallow as 8 m. These low dissolved oxygen levels limited the available fish habitat and therefore, limited the fish production potential of the lake. Hydroacoustic surveys conducted in 2003 and 2004 found that fish primarily inhabited only the upper 15 m of the water column, where dissolved oxygen concentrations were highest (Esselmann et al. 2008).

Anecdotal evidence suggests fishing has been relatively stable over the last several years at Williams Lake, and both fish size and catch rates have been good. Currently, the Williams Lake fishery seems to receive the most effort during the winter ice fishery and in the spring, just before and just after the Rainbow Trout spawning period. However, we have not conducted a creel survey at Williams Lake since 2011, and prior to that in the 1980s. During the winter 2016/2017 ice fishing period, we conducted a creel survey at Williams Lake using three automated game cameras positioned around the lake, set to take hourly photos. Additionally, we conducted angler interviews during the ice fishery when anglers were encountered. Finally, during the spring spawning season, we walked the inlet (Lake Creek) to estimate the number of spawning Rainbow Trout.

STUDY AREA AND METHODS

Williams Lake is a mesotrophic landslide lake located approximately 25.0 km southwest of Salmon, in north central Lemhi County (WGS84 45.01629°N, -113.97532°W). The lake sits at 1,600 m elevation, and has a surface area of 73 ha, maximum depth of 56 m, and mean depth of 23 m. The principle in-flow is provided by Lake Creek, with some inflow originating from springs and intermittent streams. Rainbow Trout and Bull Trout are the only fish species recorded from the lake.

We conducted a remote creel survey at Williams Lake using trail cameras from December 19, 2016 to March 23, 2017. Three trail cameras were positioned to photograph the sections of the lake that were presumed to see the most angling pressure (Figure 38), and all three cameras were set to take photos at the same time (every hour, on the hour) each day, from 0730 to 1730 h. We downloaded photos once a month and stored them at the regional office. To estimate daily angler effort, we enumerated anglers in each photo and referenced between cameras to make sure no anglers were enumerated twice during any given hour. We then summed the total number of unique anglers, and total number of angler hours observed each day from the three cameras. Daily counts were summed for each month to arrive at monthly angler effort estimates.

We visited Williams Lake on eight days during the ice fishing period to conduct angler interviews and obtain catch rate and fish size information. Interviewed anglers were asked where they resided, how long they fished, and how many fish of each species were caught and kept, and measurements were taken on fish when they were available (TL nearest mm).

On May 2, 2017 we walked approximately 2.4 km of Lake Creek, the inlet of Williams Lake, to estimate Rainbow Trout spawner abundance.

RESULTS AND DISCUSSION

We observed 357 total angler h on Williams Lake during the ice fishery between December 19, 2016 and March 24, 2017 (Table 17). Angler effort was highest during three distinct periods (1/7-1/8, 1/21 – 1/31, and 2/22 – 3/13; Figure 39). Angler effort sharply declined following heavy snowfall events around January 9 and February 1, 2017 (Figure 39). The decline in angler effort observed following each snowfall event can likely be attributed to poor access/road conditions and poor ice conditions. This degree of snowfall is not common at Williams Lake, so the estimated angler effort during the winter 2016/2017 should be considered a low value relative to a typical winter. For example, in 2011 we estimated 3,732 angler h (95% CI ± 1,771) during the ice fishery (January through March, IDFG unpublished data). Current angler effort on a typical year is likely somewhere in between the 2017 estimate and the 2011 estimate. Additionally, our estimate in 2016/2017 is based solely on monitoring the three most popular ice fishing areas at Williams Lake (Figure 38), so this should be considered a minimum effort estimate.

The majority of angling daily effort observed during the 2016/2017 winter ice fishery at Williams Lake occurred between 1030 and 1430 h (Figure 40). Anecdotal evidence suggests catch rates are highest from around 0730 to 1100 h, but many anglers likely prefer fishing after air temperature increases later in the morning, when the sun hits the lake. As expected, the majority of angling effort was observed on Saturday and Sunday, but a relatively high amount of weekday angling effort was also observed (Figure 40).

We visited the lake eight times during the 2016/2017 ice fishery to conduct angler interviews. Anglers were only encountered during four visits. We collected a total of seven interviews on two weekdays (1/9 and 1/25), and seven interviews on two weekend days (1/15 and 1/28). All interviewed anglers resided in Lemhi County. Mean catch rate on weekdays was 1.2 fish per hour (SE ± 0.3) and mean catch rate on weekend days was 1.1 fish per hour (± 0.6) for a combined average catch rate of 1.1 fish per hour (Table 17). Catch composition by interviewed anglers was 80% Rainbow Trout and 20% Bull Trout (Table 18), similar to the observed species composition in gill net surveys in 2000 (Rainbow Trout comprised 92% of the catch) (Larkin et al. 2001). Mean total length of Rainbow Trout caught by anglers in 2017 was 394 mm (range, 254–457 mm) and mean total length of Bull Trout was 301 mm (range, 174–368 mm) (Table 18).

Compared to the most recent and complete creel information we have for the Williams Lake ice fishery (1981–1987), both catch rates and fish size have improved. Catch rates observed between 1981 and 1987 averaged 0.6 fish per hour (range, 0.3 to 1.2 fish per hour) and mean total length of Rainbow Trout in the creel averaged 297 mm (range, 280–335 mm).

We estimated around 1,000 adult Rainbow Trout spawned in Lake Creek in May 2017. Enumeration of spawning fish in this section of Lake Creek is difficult due to overgrown vegetation, and enumeration of redds is difficult due to superimposition. However, our estimate in 2017 is not far off from historical observations. From 1947 to 1958, trapping operations on Lake Creek encountered anywhere between 1,000 and 4,000 adult Rainbow Trout per spawning season (IDFG unpublished data), and in 1986 biologists estimated that several thousand spawners constructed many hundred redds along the length of Lake Creek (Reingold and Davis 1987). A 1988 investigation found that spawning Rainbow Trout in Lake Creek were generally between age-2 and age-5, with males maturing around age-2 and females around age-3 (Davis and Reingold 1988).

Currently, this fishery is held in high regard by local anglers, and provides high catch rates for quality size fish. Although the water quality issue has not gone away, manipulation of the lake or the fishery in any way is not advisable, given its current high level of performance.

MANAGEMENT RECOMMENDATIONS

1. Develop a management plan for Williams Lake that includes periodical fish population monitoring, estimation of angler effort, catch, and harvest rates, and limnological sampling during both the ice and open-water fisheries

2. Work with the Forest Service to make improvements to the public access area and boat ramp/dock area for boat and bank anglers.

Table 17. Summary of angler interviews conducted during winter ice fisheries at Williams Lake in the 1980s and 2017.

Year	Total anglers interviewed	Total hours fished	Total fish harvested	Catch rate (fish/h)	Mean length (mm)
1981	148	333.5	114	0.3	284
1982	130	360.5	227	0.6	280
1983	89	275.5	156	1.2	286
1984	95	219.5	207	0.9	280
1985	212	691.0	283	0.4	290
1986	55	93.5	33	0.4	326
1987	53	168.0	45	0.3	335
Mean	112	305.9	152	0.6	297
2017	14	44.1	13	1.1	394

Table 18. Composition of angler catch collected from 14 interviews conducted in January 2017, during the ice fishing season.

Species	Total reported caught	Total reported kept	Catch rate (fish/h)	Proportion of catch	Mean TL (mm) (range)
Rainbow Trout	43	13	0.9	0.8	394 (254 - 457)
Bull Trout	11	0	0.3	0.2	301 (174 - 368)

Figure 38. Location and direction of remote cameras used at Williams Lake to determine angler effort during the 2016/2017 ice fishery, from December 19, 2016 to March 23, 2017.

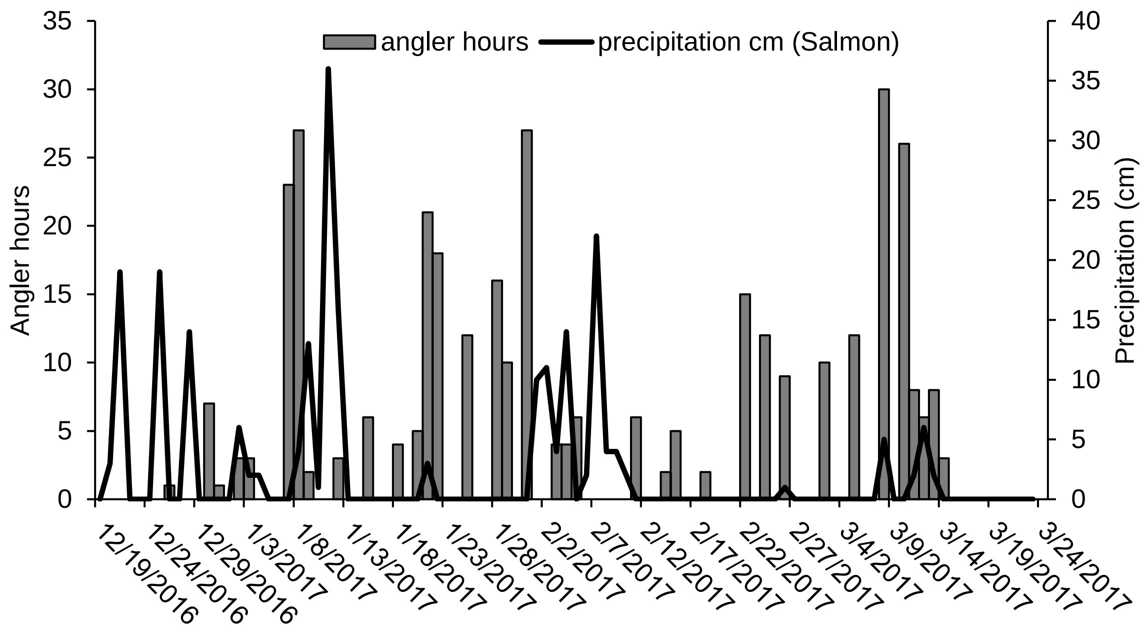

Figure 39. Angler effort (h) per day during the 2016/2017 winter ice fishery at Williams Lake. Grey bars show angler effort (h) and black line shows daily snowfall (cm) in Salmon, Idaho.

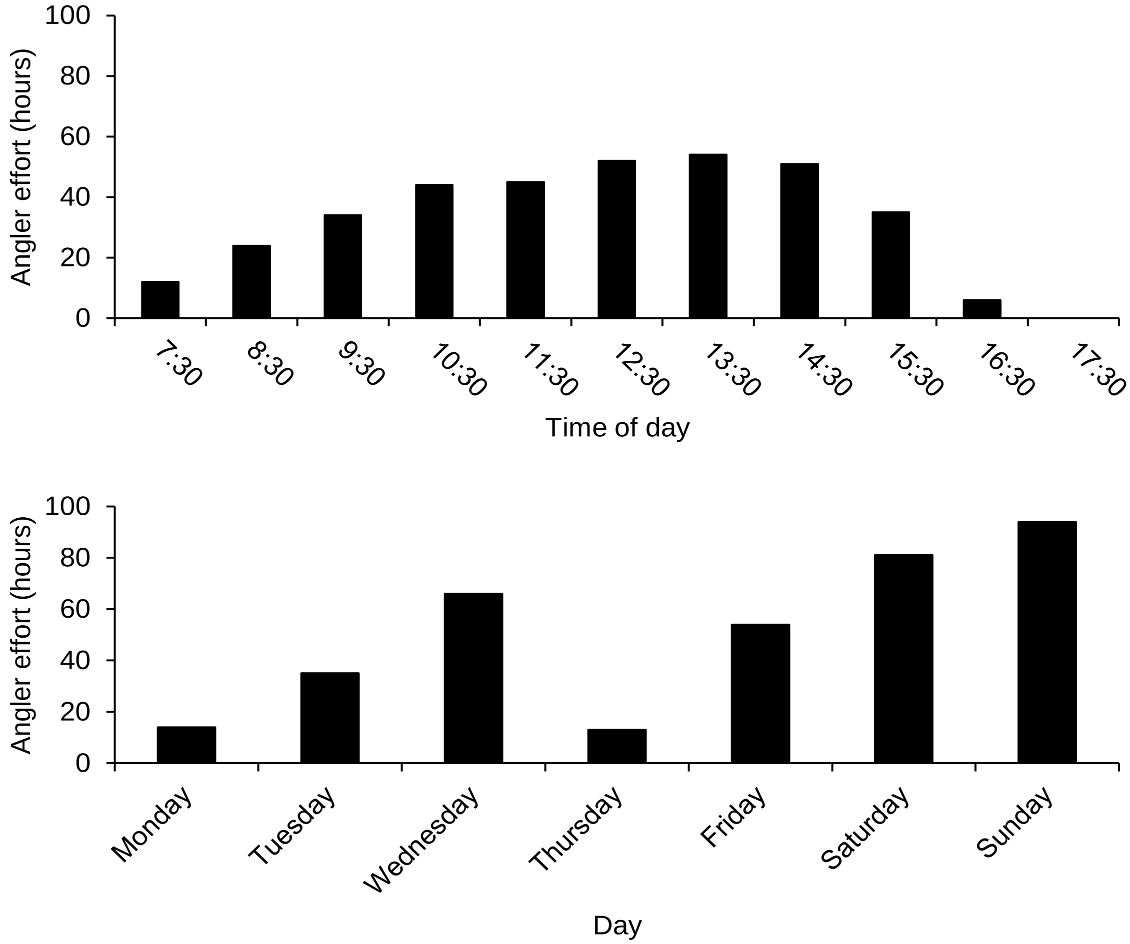

Figure 40. Angler effort (h) by time of day and day of the week, during the winter 2016/2017 ice fishery.

RIVERS AND STREAMS:

SALMON RIVER ELECTROFISHING SURVEYS

ABSTRACT

Raft mounted electrofishing equipment was used to determine fish composition, abundance, distribution, and size structure in three continuous transects (combined distance of 40.8 km) of the main stem Salmon River in fall, 2017. Non-target species (mainly Mountain Whitefish *Prosopium williamsoni*) outnumbered target species in all transects we surveyed in 2017. However, non-target species were not netted or enumerated. For target species, overall, we caught a total of 1,670 fish during electrofishing surveys in 2017. Species composition of the overall catch was 52.7% wild Chinook Salmon *Oncorhychus tsawytscha* parr (*n* = 880), 23.1% *O. mykiss* parr (*n* = 386, 97% natural origin and 3% hatchery origin), 16.9% Westslope Cutthroat Trout *O. clarkii* (*n* = 283), 4.9% Bull Trout *Salvelinus confluentus* (*n* = 83), 1.9% adult Rainbow Trout (> 300 mm TL*; n* = 32, 78% natural origin and 22% hatchery origin), and < 1.0% trout hybrids (Cutthroat x Rainbow *n* = 6). Target species catch rates showed that, in general, Chinook Salmon parr were relatively more abundant below the East Fork Salmon River, but all other target species did not differ in their relative abundance between transects.

Overall estimated abundance, using mark/recapture, for Westslope Cutthroat Trout in the 40.8 km section of river was 2,038 (95% CI 1,460 – 4,911), or 50 fish/km. For Bull Trout, we estimated overall abundance in the entire reach at 369 (95% CI 143 – 513), or 9 fish/km, and for O. mykiss parr, we estimated abundance at 8,694 in the entire reach (95% CI 4,873 – 40,250), or 213 fish/km. We marked 9 adult Rainbow Trout, and only encountered 1 recapture, so abundance was not estimated.

Trout size structure, body condition, and stock quality (PSD-Q) did not differ between transects surveyed in 2017, and was similar to that which was observed in the East Fork to Deadman transect in 2015 and 2016. These results indicate that the East Fork to Deadman transect is a valid representation of the trout community in the upper reaches of the main stem Salmon River, near the mouth of the East Fork Salmon River, and should continue being monitored for trend examination.

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INTRODUCTION

The upper Salmon River already serves as a popular fishery for targeting anadromous Chinook Salmon *Oncorhychus tshawytscha* and steelhead *O. mykiss*, but is under-utilized as a trout fishery. IDFG's current fisheries management plan lists "Improv[ing] the quality of resident trout fishing in the main stem Salmon River during the summer months" as an objective (IDFG 2019). Our ability to improve trout fishing on the upper Salmon River is hindered by the fact that we currently know little about composition, abundance, distribution, and size structure of trout in the river.

The Salmon River supports a wide range of fish species, including anadromous salmon and steelhead, and several resident species including Rainbow Trout *O. mykiss*, Cutthroat Trout *O. clarkii*, Bull Trout *Salvelinus confluentus*, Brook Trout *S. fontinalis*, Mountain Whitefish *Prosopium williamsoni*, Northern Pikeminnow *Ptycheilus oregonensis*, various sucker species *Catastomus* spp., dace *Rhinichthys* spp., sculpin *Cottus* spp., Chiselmouth Chub *Acrocheilus alutaceus*, and Redside Shiner *Richardsonius balteatus*. Electrofishing surveys conducted on the upper main stem Salmon River in 1998 found that suckers (var. spp.) and Mountain Whitefish (combined) made up 67% to 89% of the catch, while trout made up only 1% to 4% (Curet et al. 2000).

Trout fishing in the upper Salmon River can be good during certain times of the year. Spatial distribution of resident trout throughout the upper main stem Salmon River varies seasonally, and is likely related to seasonal habits and requirements for each species (i.e. spawning, foraging, and overwintering; Schoby, 2006). Rainbow Trout and Westslope Cutthroat Trout mainly spawn in smaller tributaries in the spring, but occupy various parts of the main stem river at other times of the year. Bull Trout use the main stem river for overwintering and foraging during fall, winter, and spring, but aggregate in the upper reaches of smaller tributaries for spawning from mid-summer to early fall (Schoby, 2006).

With little information regarding the abundance and size structure of resident trout in the upper main stem Salmon River, it is difficult to make informed management decisions to improve the quality of resident trout fishing. Baseline information that includes fish densities, species composition, and size structure information will help us identify reaches within the Salmon River that currently offer quality resident trout angling opportunities, and those in need of improvement. Establishing trend reaches and annual sampling will allow us to monitor long-term trends of resident salmonid populations, and evaluate the effectiveness of future management decisions aimed at improving fishing in the basin.

OBJECTIVES

1. Establish trend monitoring sites on the upper main stem Salmon River and collect baseline information relating to trout abundance, movement, and size structure.

2. Evaluate whether Westslope Cutthroat Trout, Rainbow Trout, and Bull Trout are moving in and out of transect reaches during the fall sampling period, to determine whether this affects mark/recapture abundance estimates.
3. Locate overwintering Chinook Salmon and steelhead parr, deploy PIT tags in ~150-200 of each species in each transect, and evaluate outmigrant survival through the hydrosystem in 2018.

STUDY SITES AND METHODS

We electrofished a continuous 40.8-km reach of the main stem Salmon River in October, 2017, from the Torrey's Hole boat ramp to the Deadman Hole boat ramp. This entire section was divided into three transects; Torrey's Hole boat ramp (44.2556°N, -114.5935°W) to Squaw Creek (South Butte boat ramp; 44.2493°N, -114.4542°W) (15.7 km), Squaw Creek to the East Fork Salmon River (EFSR) (44.2663°N, -114.3273°W) (12.9 km), and EFSR to Deadman Hole boat ramp (44.3451°N, -114.2700°W) (12.2 km). The EFSR to Deadman Hole transect has now been surveyed for 3 consecutive years. As was done in previous years, each of the three transects were electrofished over three days, for a total of nine days. In 2017, all target fish were PIT tagged and marked with a fin clip to assign each fish to the transect and pass in which they were marked. When fish were captured during an electrofishing pass, they were examined for marks/tags and were given a mark/tag if one was not already detected. Electrofishing surveys were conducted in the first, second, and third weeks of October, 2017.

Each of the transect reaches were sampled using two rafts operating in tandem, mounted with Midwest Electrofishing Systems Infinity control boxes powered by Honda 5000-W generators. Pulsed DC current was applied to the water using two booms with Wisconsin ring anodes on each boat. Control box settings were between 200-350 volts, at a frequency of 60 Hz and 25% duty cycle, and typically between 4 – 8 Amps and 1500 to 1800 watts. One fisheries technician on the front of each boat attempted to net all trout spp., Chinook Salmon parr, steelhead parr, and any rare species encountered (e.g. Smallmouth Bass *Micropterus dolomieu*). Non-target species (Mountain Whitefish, Northern Pikeminnow, various sucker species, and Redside Shiner) were not netted because they were so abundant it would have complicated our objective of collecting information on target species. Anadromous adults (Chinook Salmon and steelhead) were not netted during any of our surveys. If anadromous adults were encountered, shocking was temporarily halted, and resumed approximately 50 m downstream.

All netted fish were anaesthetized using Aqui-S 20E fish anesthetic. All reporting requirements for using Aqui-S 20E as a trial anesthetic were followed (i.e. careful tracking of amounts used, fish handling times, and fish recovery times). Fish were identified, scanned for PIT tags and other tags/marks, measured (mm TL), and weighed (g), and all target species (with the exception of Chinook Salmon parr) were given a fin clip. All *O. mykiss* smaller than 300 mm TL (both steelhead and Rainbow Trout parr) were grouped together as *O. mykiss* parr, and those larger than 300 mm TL were examined further to subjectively determine whether they were resident Rainbow Trout or juvenile steelhead. Adipose-clipped *O. mykiss* that were slightly larger than 300 mm TL were considered hatchery steelhead based on morphological characteristics. All target fish that did not already contain a PIT tag were given one. All PIT tag information (marked or recaptured) was entered into ptagis.org.

Trout abundance was summarized in two ways: catch per unit effort and mark/recapture estimates. Catch-per-unit effort summaries are reported for each transect, but mark/recapture abundance estimates are combined for the entire 40.8-km reach of river. Mark/recapture abundance estimates were only calculated for Westslope Cutthroat Trout, Bull Trout, and *O. mykiss* parr due to insufficient number of recaptures for all other species. To calculate mark/recapture abundance, we divided all Westslope Cutthroat Trout and Bull Trout into classes (<261 mm, 261 mm – 360 mm, and >360 mm for Westslope Cutthroat Trout and <500 mm or >501 mm for Bull Trout), and calculated abundance for each size class using the Schnabel method for multiple mark/recapture events. Size class estimates were then summed and divided by the section length to estimate fish/km. The estimate for O. mykiss parr combined all O. mykiss < 300 mm TL.

To compare fish size and condition between transects and years, we built length-frequency histograms for each species of trout in each section, and calculated relative weights for all trout captured in each section (Blackwell et al. 2000). We also calculated proportional stock density for trout in each section using minimum stock (220 mm TL) and quality lengths (330 mm TL) described by Gabelhouse (1984).

We PIT tagged nearly all Chinook Salmon and steelhead parr in each transect in 2017 to evaluate their survival downstream to Lower Granite Dam in the spring, 2018. In 2016, we PIT tagged 765 steelhead parr and 373 Chinook Salmon parr from 7 main stem Salmon River transects (Messner et al. *in press*) and evaluated their survival to Lower Granite Dam in spring 2017. Tagging and Interrogation files were generated in ptagis in order to run survival estimates in PitPro. Survival estimates to Lower Granite Dam for anadromous parr tagged in 2016 will be presented in this report.

RESULTS

We electrofished 9 days in October 2017 to conduct a three-pass mark/recapture survey on a continuous 40.8 km section of the main stem Salmon River, from Torrey's Hole boat ramp to Deadman Hole boat ramp. The 40.8 km section of river was divided into three transects that were sampled three times each (Figure 41). All effort combined, we electrofished for a total of 45.5 h, and caught 1,670 target fish (trout spp., Chinook Salmon and steelhead parr; CPUE = 36.7 fish/h), 26 of which were recaptures. Overall target species catch composition (n = 1,670) was 52.7% wild Chinook Salmon parr (n = 880), 23.1% *O. mykiss* parr (n = 386, 97% natural origin and 3% hatchery origin), 16.9% Westslope Cutthroat Trout *O. Clarkii* (n = 283), 4.9% Bull Trout *Salvelinus confluentus* (n = 83), 1.9% adult Rainbow Trout (> 300 mm TL; n = 32, 78% natural origin and 22% hatchery origin), and < 1.0% trout hybrids (Cutthroat x Rainbow n = 6). Catch rates between the three transects for target species were relatively very similar, with the exception of Chinook Salmon parr. Relative abundance of Chinook Salmon parr was significantly higher below the East Fork Salmon River than above (Figure 42).

Overall estimated abundance, using mark/recapture, for Westslope Cutthroat Trout in the 40.8 km section of river was 2,038, or 50 fish/km (Table 19). For Bull Trout, we estimated overall abundance in the entire reach at 369, or 9 fish/km, and for *O. mykiss* parr, we estimated abundance at 8,694 in the entire reach, or 213 fish/km (Table 19). We marked 9 adult Rainbow Trout, and only encountered 1 recapture, so abundance was not estimated.

Size structure and condition of Westslope Cutthroat Trout, Rainbow Trout, and Bull Trout was very similar between the three transects (Figures 43 through 45). In the entire 40.8 km reach, mean TL for Westslope Cutthroat Trout was 308 mm (range, 176–595), mean TL for adult Rainbow Trout (>300 mm) was 395 mm (range, 316–460), and mean TL for Bull Trout was 317 mm (range, 155–734; Table 20). Westslope Cutthroat Trout PSD-Q was 49%, 53%, and 44% in the Torrey's to Squaw, Squaw to EFSR, and EFSR to Deadman transects, respectively in 2017, and relative weights were similar for Westslope Cutthroat Trout in all three transects (mean = 90) (Figure 46) PSD-Q for Bull Trout in 2017 was 59%, 54%, and 40% in the Torrey's to Squaw, Squaw to EFSR, and EFSR to Deadman transects, respectively (Table 20), and relative weights were similar between the three transects as well (mean = 96; Figure 46). We caught 17 adult Rainbow Trout (> 300 mm TL) in the Torrey's to Squaw transect, 5 in the Squaw to EFSR transect, and 6 in the EFSR to Deadman transect in 2017 (Figure 45). Adult Rainbow Trout made up only 4%, 10%, and 6% of the total number of *O. mykiss* captured in each of the three transects, respectively. Rainbow Trout < 300 mm TL could not be distinguished from juvenile steelhead, so

PSD-Q was not calculated for Rainbow Trout. For all adult Rainbow Trout (>300 mm TL) combined, mean relative weight was 90 (range, 64–109; Figure 46).

In 2016, we PIT tagged 373 Chinook Salmon parr and 765 steelhead parr between seven transects in the main stem Salmon River (Messner et al. *in press* – 2016 report; Table 21). PitPro software estimated overall survival (± 95% CI) to Lower Granite Dam for Chinook Salmon parr was 30% (± 4%) in 2017, and overall survival for steelhead parr was 18% (± 3%; Table 21). Among the seven transects surveyed in 2016, Chinook Salmon parr survival was highest in the Rattlesnake to Elevenmile transect (48% ± 14%), and lowest in the East Fork to Deadman transect (16% ± 5%), and steelhead parr survival was highest in the Deer Gulch to Colston transect (45% ± 39%) and lowest in the East Fork to Deadman transect (2% ± 2%) (Table 21).

DISCUSSION

Catch rates for *O. mykiss* parr, Bull Trout, Rainbow Trout, and Westslope Cutthroat Trout have remained relatively stable over the past three years in the East Fork to Deadman transect (Figure 42). Relative abundance of Chinook Salmon parr was significantly higher in 2017 than in 2016 (Chinook Salmon were not netted in 2015; Figure 42). Snorkel surveys in the main stem Middle Fork Salmon River in 2017 also found relatively higher abundances of Chinook Salmon parr in 2017, compared to 2015 and 2016 (see MFSR section of this report). We suspect the extreme flooding events that occurred in the Upper Salmon River basin in spring 2017 may have influenced these observations.

Estimated abundance of Westslope Cutthroat Trout (MRC estimate) in the 40.8-km reach in 2017 was two times higher than was estimated in the East Fork to Deadman section in 2016 (Table 19). However, our abundance estimates have consistently produced wide ranges of variation due to low number of recaptures. The estimate produced in 2017 is likely more accurate than the 2016 estimate, as we were able to estimate abundance by size class and account for fish moving between transects in 2017. Based on recaptured PIT tags, we found that nine of the 14 Westslope Cutthroat Trout we recaptured in 2017 were marked in a different transect than where they were recaptured. The same was true for one of the seven Bull Trout we recaptured and the one and only adult Rainbow Trout we recaptured. This suggests trout are actively moving relatively long distances throughout the Salmon River during our sampling period in the fall, which has likely reduced our recaptured of marked fish and generating abundance estimates in previous years. Recapture efficiencies are also likely affected by our inability to effectively shock deep overwintering pools, or to shock the entire width of the river using only two rafts. In any case, relative abundance values (fish/h) seem to be excellent indicators of differences in abundance between transects.

This is the first year we have been able to estimate mark/recapture abundance for Bull Trout in the main stem Salmon River, which are relatively low in abundance compared to Westslope Cutthroat Trout (Figure 42). However, compared to downstream reaches of the Salmon River surveyed in 2016 (Messner et al. *in press*), Bull Trout seem to be more common in the fall, in the section of river we surveyed in 2017. In 2015, 2016, and 2017, all of the six previously PIT tagged Bull Trout we have caught during our main stem Salmon River surveys were tagged at the adult collection facility on the East Fork Salmon River, between 2011 and 2014. All six of those Bull Trout now have multiple records of fish length over time which, combined with hard-structure ageing data, could provide valuable information about fluvial Bull Trout growth in the region. Based on recapture events for the six fluvial Bull Trout we've encountered over the past three years, mean annual growth was 47.2 mm TL per year (± 7.2 mm

SE) (Figure 47). We collected one Bull Trout mortality in 2017 (fish #4 in Figure 47), which was 690 mm TL. Fin rays were obtained from the fish and age was estimated at 11 years.

Rainbow Trout were the least abundant trout species found in the section of river we surveyed in 2017 based on catch rates and number of fish encountered. In 2016, we found that adult Rainbow Trout (>300 mm TL) were relatively more abundant in transect reaches between the Pahsimeroi River and Elk Bend, than in transects higher or lower on the Salmon River (Messner et al. *in press* – 2016 report). The fact that there is a fluvial Rainbow Trout stronghold in the Pahsimeroi River (see Pahsimeroi Rainbow Trout section of this report) likely contributes to higher abundances of Rainbow Trout in those reaches of the Salmon River. However, other strongholds in the area may exist as well, and further studies should investigate where they are and how they contribute to the main stem Salmon River fluvial Rainbow Trout population.

Size structure, stock quality, and fish condition for Westslope Cutthroat Trout and Bull Trout was very similar in the East Fork to Deadman transect in 2015, 2016, and 2017, and was very similar between the three transects we surveyed in 2017 (Table 20, Figures 43 through 46). In 2016, we found that PSD-Q for Westslope Cutthroat Trout was highest in the East Fork to Deadman transect, and for Bull Trout was second highest in this transect, compared to lower reaches of the Salmon River. The fact that size structure, stock quality, and fish condition was very similar for all three transects surveyed in 2017 suggests the East Fork to Deadman section is an accurate representation of the fish community in the upper reach of the Salmon River, and will continue to be a valuable transect for documenting trends in fish abundance, size, and condition in future years as more data is collected. As trout community characteristics in the East Fork to Deadman transect in 2017 were very similar to that which was observed in 2015 and 2016, it appears community composition, size structure, and fish condition have been relatively very stable over the last three years in this transect.

We PIT tagged a total of 274 Westslope Cutthroat Trout (including Cutthroat x Rainbow hybrids), 72 Bull Trout, 13 adult Rainbow Trout (>300 mm TL), 369 *O. mykiss* <300 mm TL (both Rainbow Trout and steelhead juveniles), and 780 Chinook Salmon parr in 2017. We also captured two Westslope Cutthroat Trout, four Bull Trout, one *O. mykiss* parr, and nine Chinook Salmon parr that were tagged elsewhere in the Upper Salmon River basin, prior to our capture event. For resident fish PIT tagged in 2017, movement throughout the basin will be assessed based on interrogations and recaptures, and some growth information can be gathered with recaptures throughout the basin over the coming years. An in-depth query in December 2017 of all resident trout PIT tags encountered during our main stem electrofishing, above the Pahsimeroi River, over the past three years yielded multiple detections for 12 adult Rainbow Trout, 13 Bull Trout, and 40 Westslope Cutthroat Trout. A few trends can be gathered from this data. For example, three Westslope Cutthroat Trout we PIT tagged in October, 2016 in the Pennal to Watt's and East Fork to Deadman transects were detected using the Lemhi River in the spring of 2017, presumably for spawning. The mouth of the Lemhi River is over 140 km downstream of the East Fork Salmon River, which is quite a bit higher than the average home range, size estimated by Schoby (2006) for Westslope Cutthroat Trout in the upper Salmon River basin (67.4 ± 47.6 km), but still within the maximum observed home range (235.9 km). Additionally, one Rainbow Trout and one Westslope Cutthroat Trout PIT tagged in the Kilpatrick to Elk Bend transect in 2016 were detected using the Yankee Fork Salmon River in spring, 2017. The mouth of the Yankee Fork of the Salmon River is over 130 km upstream of the location where these fish were tagged, again showing significant movement throughout the basin. Based on these detections, it appears that trout in the upper Salmon move both from upstream tributaries to downstream wintering areas, and vice versa. Movement and growth data based on PIT tag detections will be best summarized as more

PIT tags are deployed and interrogated, in order to have sufficient sample sizes for each species to generate movement and growth trends.

Survival to Lower Granite Dam in 2018 will be calculated for Chinook Salmon and steelhead parr tagged in 2017, as was done for Chinook Salmon and steelhead parr tagged in 2016. For both species of parr, survival was lowest in the highest transect we surveyed in 2016 (East Fork to Deadman) which is where all parr were tagged in 2017. In 2016, we had only tagged 51 Chinook Salmon parr and 42 steelhead parr in the East Fork to Deadman transect, so higher numbers of those fish tagged in 2017 will help us refine our survival estimates for that reach. Comparatively, survival estimates for age-1 Chinook Salmon smolts that emigrated from the Pahsimeroi River in the spring of 2017 was 0.70 (± 0.04). Survival estimates were not conducted for *O. mykiss* smolts leaving the Pahsimeroi in 2017.

Very few anadromous adults were encountered during electrofishing in 2016. As per our permit guidelines, when an adult Chinook Salmon or steelhead is encountered, shocking is suspended to allow the fish to move upstream past the shocking boats. We briefly encountered one adult steelhead in the Torrey's to Squaw transect in 2017, but no other adult anadromous fish were observed.

MANAGEMENT RECOMMENDATIONS

1. Monitor survival and migration timing of PIT tagged juvenile steelhead and Chinook Salmon (presumably overwintering in the main stem Salmon River), and compare with survival estimates from spring emigrating juveniles tagged at screw traps in the Lemhi and Pahsimeroi Rivers.

2. Design and conduct radio telemetry studies throughout the basin to locate spawning tributary strongholds for large fluvial Rainbow and Cutthroat trout, using future main stem electrofishing surveys in the fall as potential tagging events.

3. Use electrofishing catch rates to describe relative abundance of fluvial trout in sections of the main stem Salmon River in the future, as these seem to be characteristic of actual abundance, and likely more reliable than mark/recapture-based abundance estimates.

Table 19. Numbers of *O. mykiss* parr, Westslope Cutthroat Trout, and Bull Trout captured (C), marked (M), and recaptured (R) during three passes of electrofishing surveys on a 40.8 km section of the Salmon River in 2017. Numbers were used to estimate abundance in each transect, following the Schnabel method.

Pass #	Fish length (TL mm)	C	M	R	Point estimate	95% Confidence interval
			O. mykiss parr			
1	<300 mm	197	197	0	--	--
2	<300 mm	90	89	1	--	--
3	<300 mm	90	87	3	8,694	(3,867 – 20,800)
			Westslope Cutthroat Trout			
1	<261	47	47	0	--	--
	261 – 360 mm	53	53	0	--	--
	>360 mm	17	17	0	--	--
2	<261	23	22	1	--	--
	261 – 360 mm	45	43	2	--	--
	>360 mm	19	16	3	--	--
3	<261	14	12	2	512	(210 – 1,264)
	261 – 360 mm	41	39	2	1,264	(562 – 3,024)
	>360 mm	30	29	1	263	(117 – 628)
			Bull Trout			
1	<500 mm	28	28	0	--	--
	>500 mm	9	9	0	--	--
2	<500 mm	17	16	1	--	--
	>500 mm	11	4	7	--	--
3	<500 mm	21	19	2	350	(143 – 865)
	>500 mm	4	4	0	19	(10 – 40)

Table 20. Size structure summary for target species collected during Salmon River electrofishing in 2017.

Transect name	Rainbow Trout > 300 mm TL		Westslope Cutthroat Trout		Bull Trout	
	Mean TL (mm) (± SE)	PSD-Q	Mean TL (mm) (± SE)	PSD-Q	Mean TL (mm) (± SE)	PSD-Q
Torrey's to Squaw	346.5 (± 17.4)	--	309.0 (± 5.8)	44%	319.3 (± 22.9)	40%
Squaw to EFSR	350.8 (± 25.9)	--	316.5 (± 8.9)	49%	339.1 (± 40.5)	59%
EFSR to Deadman	376.7 (± 17.9)	--	299.2 (± 7.1)	53%	259.0 (± 28.2)	54%

Table 21. Estimates of survival (± SE) to Lower Granite Dam for Chinook and steelhead parr PIT tagged in seven transects of the main stem upper Salmon River in September and October, 2016. For comparison, survival of age-1 Chinook smolts tagged at the Pahsimeroi River screw trap are also included.

Transect name	Chinook Salmon parr		Steelhead parr	
	n	survival (± SE)	*n*	survival (± SE)
EFSR to Deadman	51	0.16 (0.05)	42	0.02 (0.02)
Pennal to Watts	63	0.23 (0.05)	121	0.11 (0.04)
Deer Gulch to Colston	44	0.18 (0.07)	177	0.45 (0.39)
Kilpatrick to Elk Bend	121	0.40 (0.12)	144	0.24 (0.09)
Rattlesnake to Elevenmile	62	0.48 (0.14)	96	0.16 (0.04)
Morgan Bar to Red Rock	29	0.24 (0.08)	159	0.19 (0.04)
Deadwater to Indianola	3	inadequate sample size	26	0.27 (0.16)
All transects combined	373	0.30 (0.04)	765	0.18 (0.03)
Pahsimeroi R. age-1 Screw trap	700	0.70 (0.04)	n/a	n/a

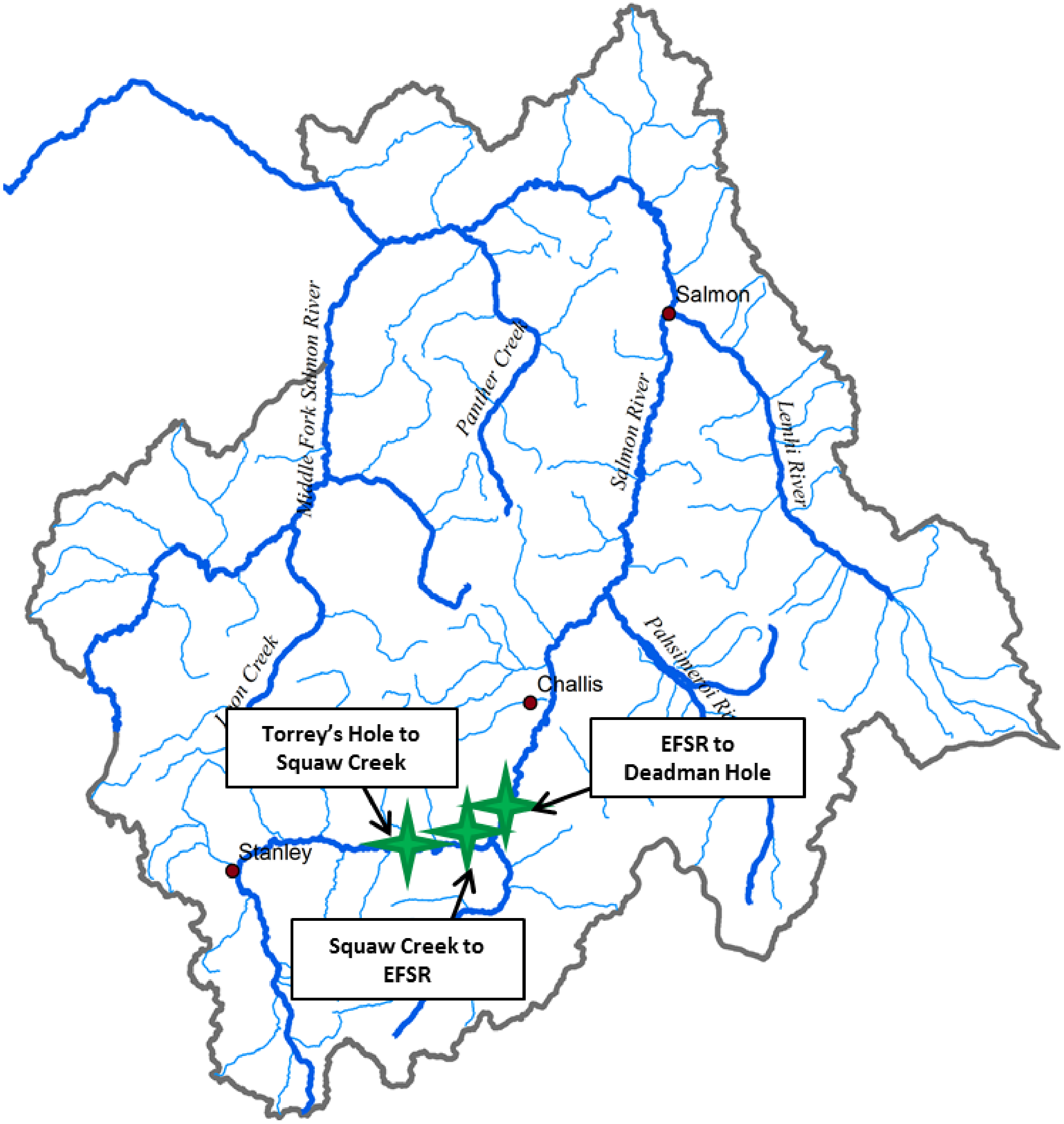

Figure 41. Approximate locations of sites surveyed along the main stem Salmon River in 2017.

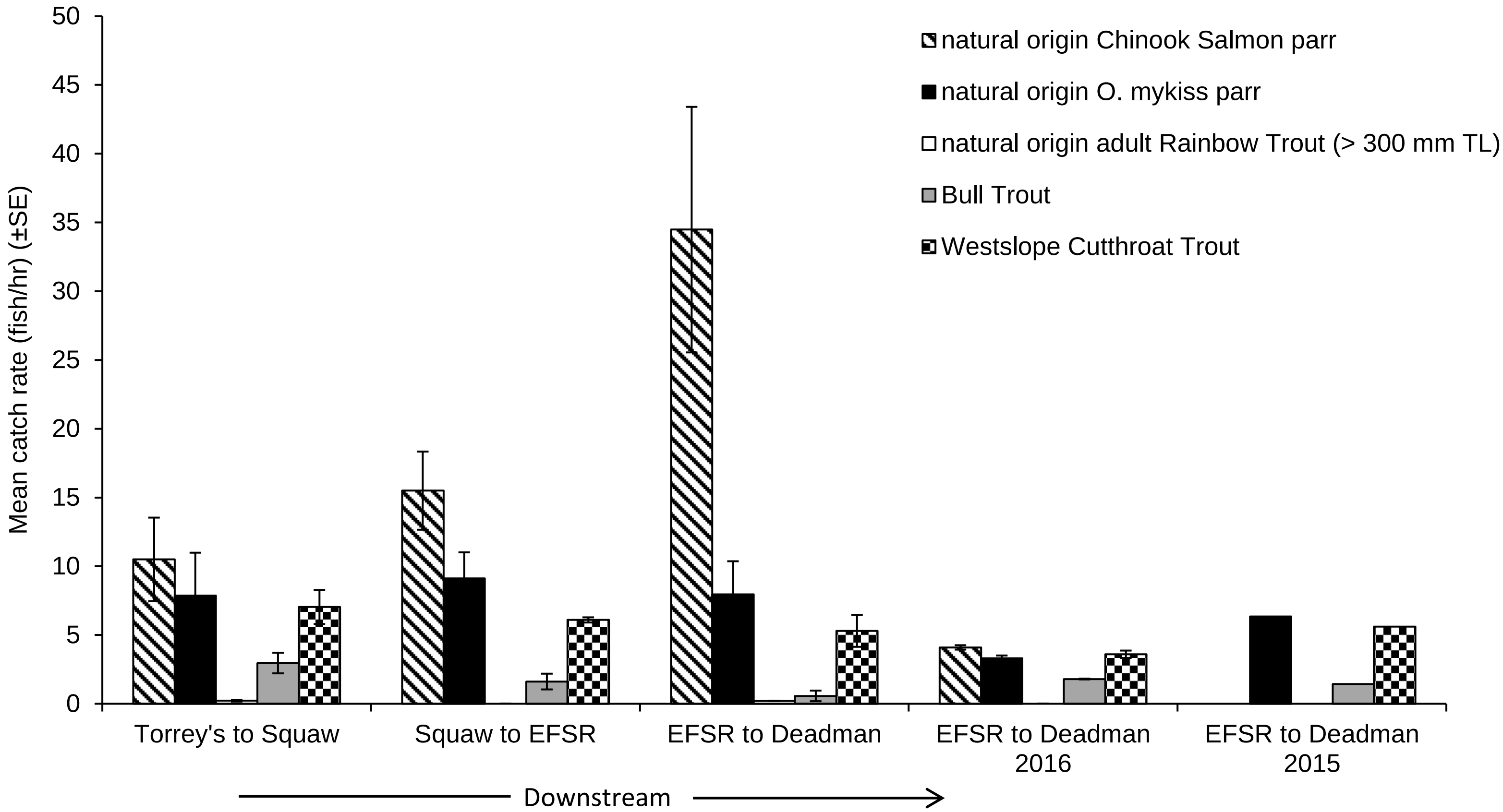

Figure 42. Mean catch rates (fish/h) (± SE) for top five target species captured in each of the main stem Salmon River electrofishing transects in October, 2017, and in the East Fork Salmon River (EFSR) to Deadman transect in October 2015 and 2016 for reference. Note: Chinook Salmon parr were not netted in the EFSR to Deadman transect in 2015, and SE bars were not constructed for 2015 data.

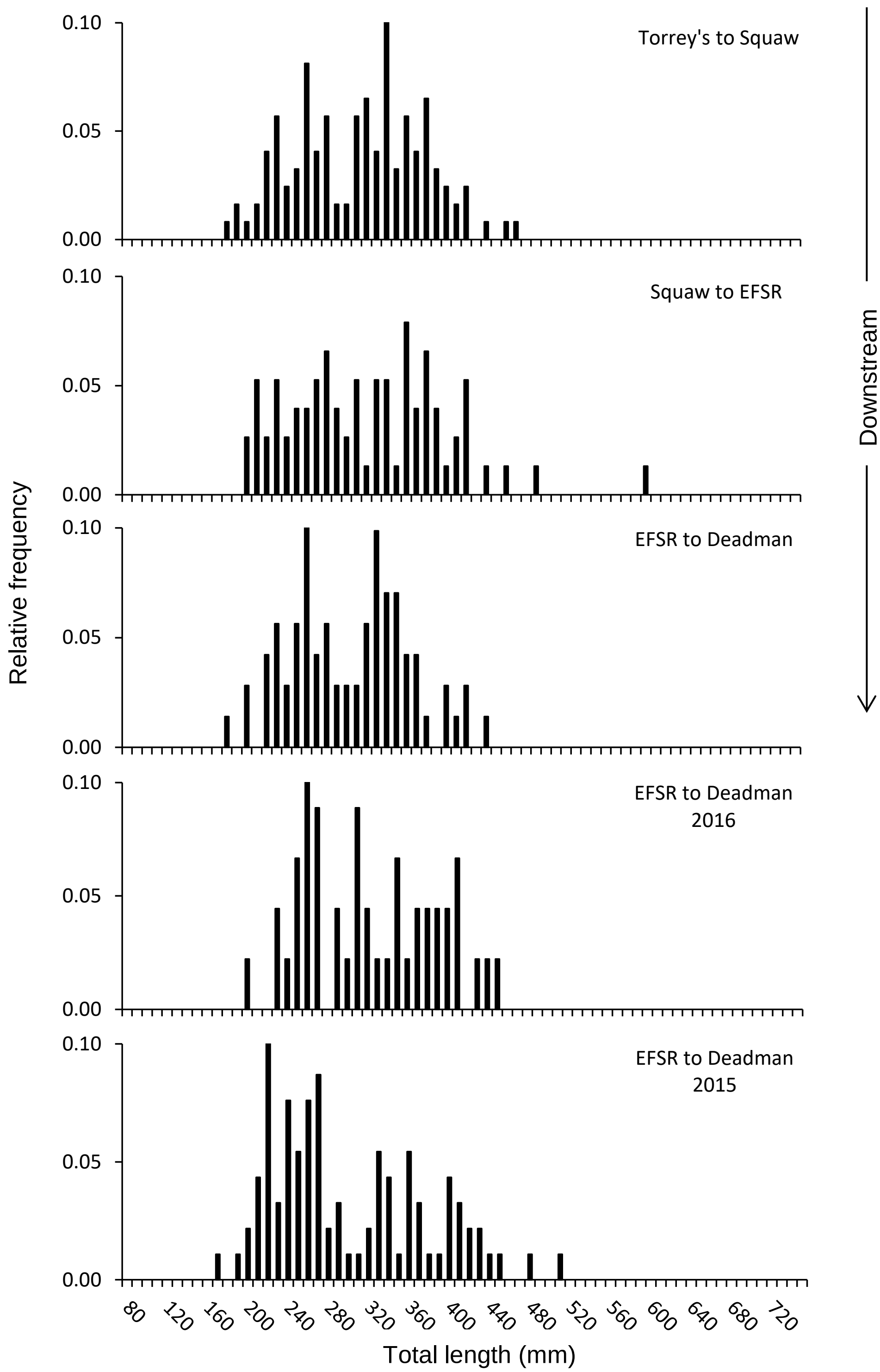

Figure 43. Westslope Cutthroat Trout length frequency in all main stem Salmon River transects surveyed in October 2017, and in the East Fork Salmon River (EFSR) to Deadman transect in 2015 and 2016.

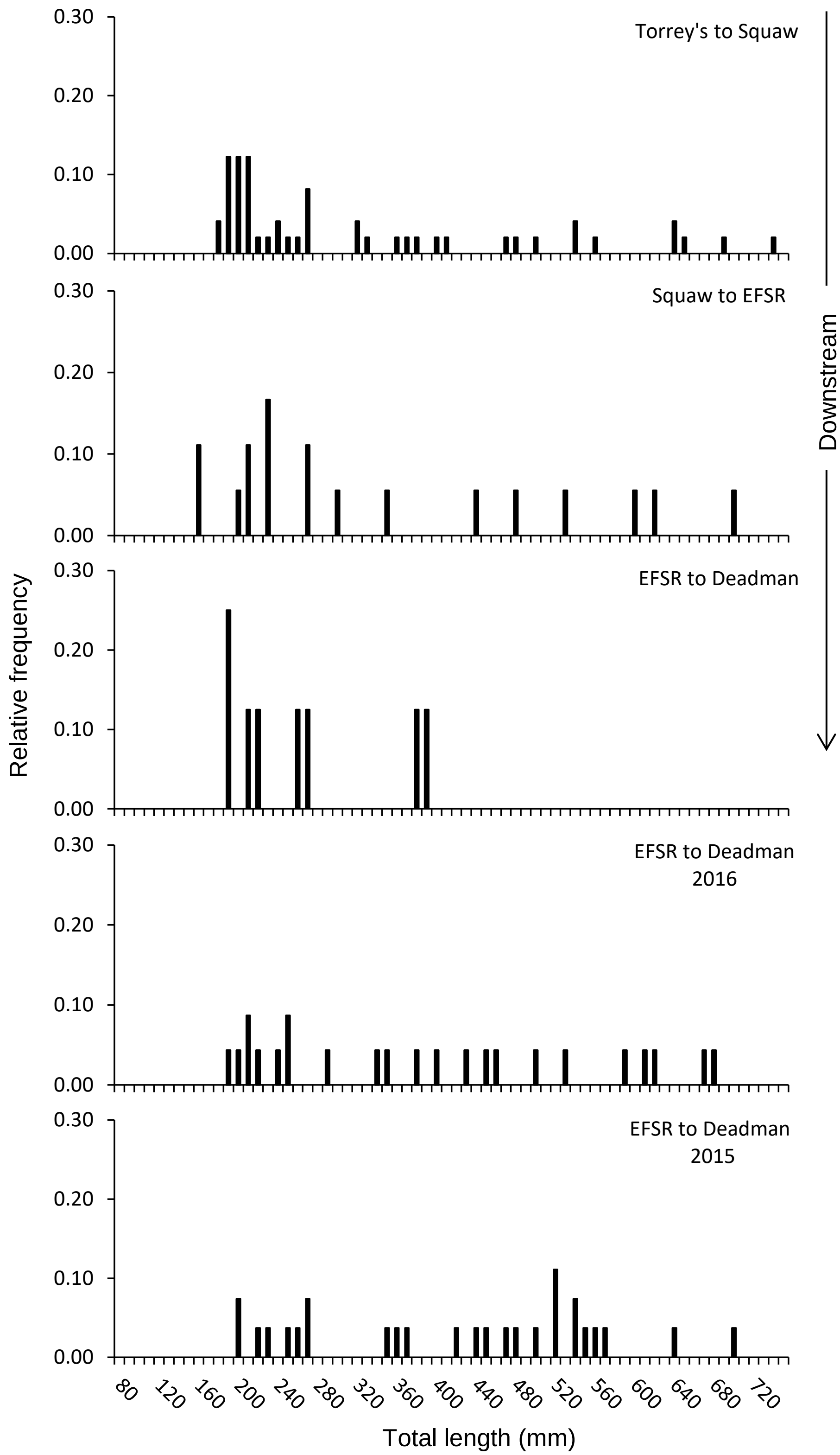

Figure 44. Bull Trout length frequency in all main stem Salmon River transects surveyed in October 2017, and in the East Fork Salmon River (EFSR) to Deadman transect in 2015 and 2016.

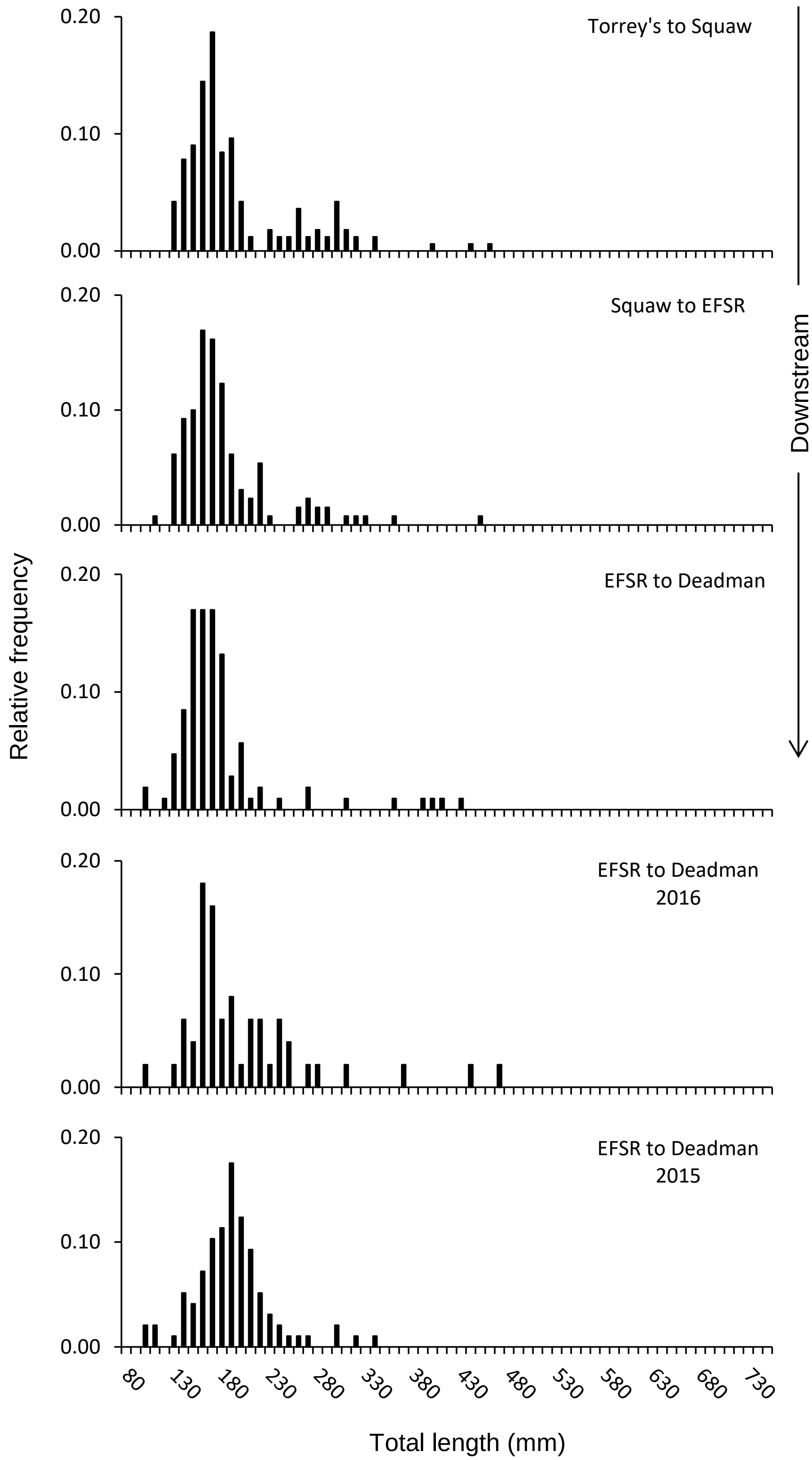

Figure 45. *O. mykiss* length frequency in all main stem Salmon River transects surveyed in October 2017, and in the East Fork Salmon River (EFSR) to Deadman transect in 2015 and 2016.

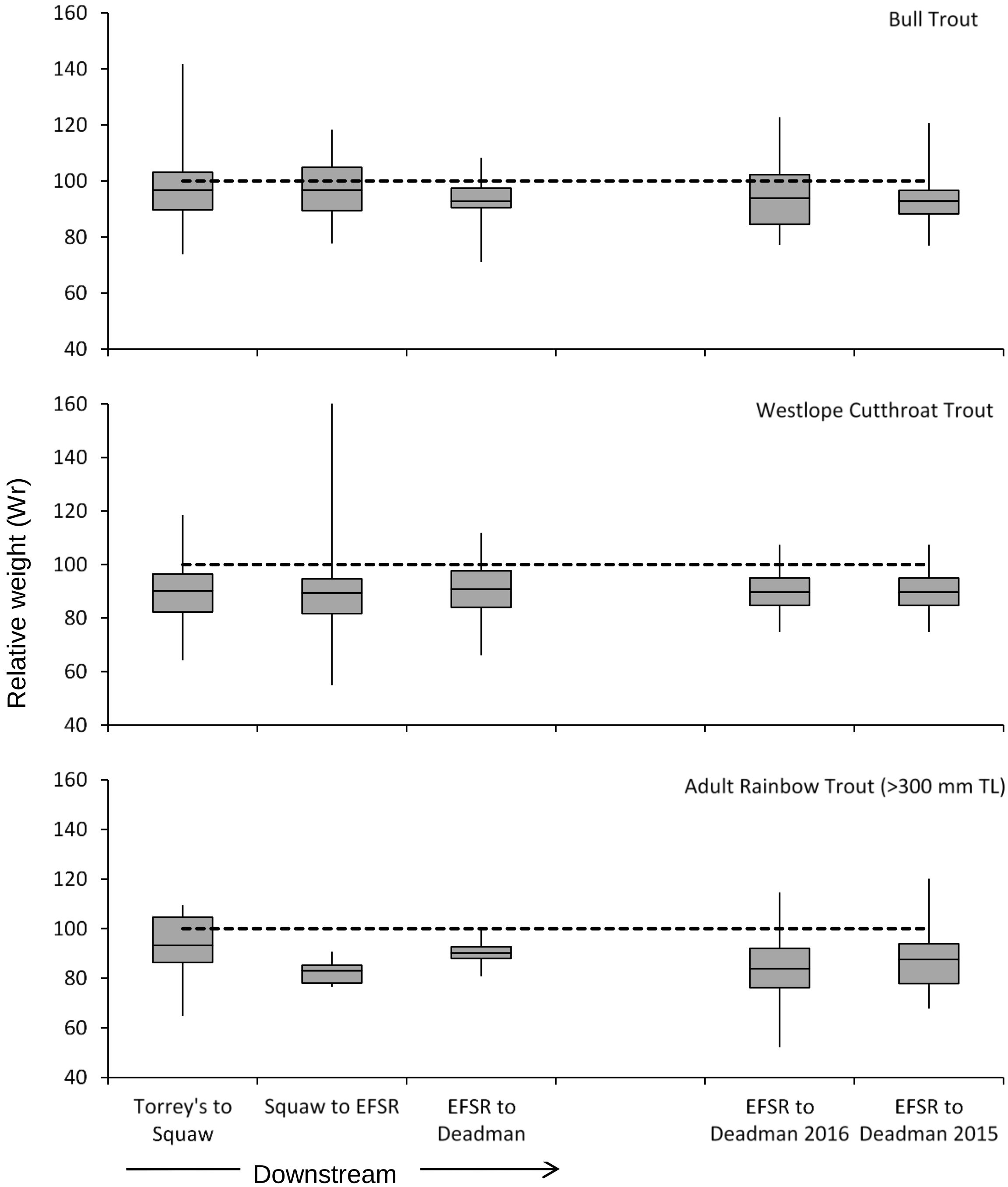

Figure 46. Mean relative weights for Westslope Cutthroat Trout, Rainbow Trout, and Bull Trout caught in the main stem Salmon River during electrofishing surveys in October, 2017, and in the East Fork Salmon River (EFSR) to Deadman transect in 2015 and 2016. Box represents Q1 to Q3 and mean, and whiskers show minimum and maximum observed values for each transect. Dashed line at W_r = 100 represents species average based on standard weight for a given length.

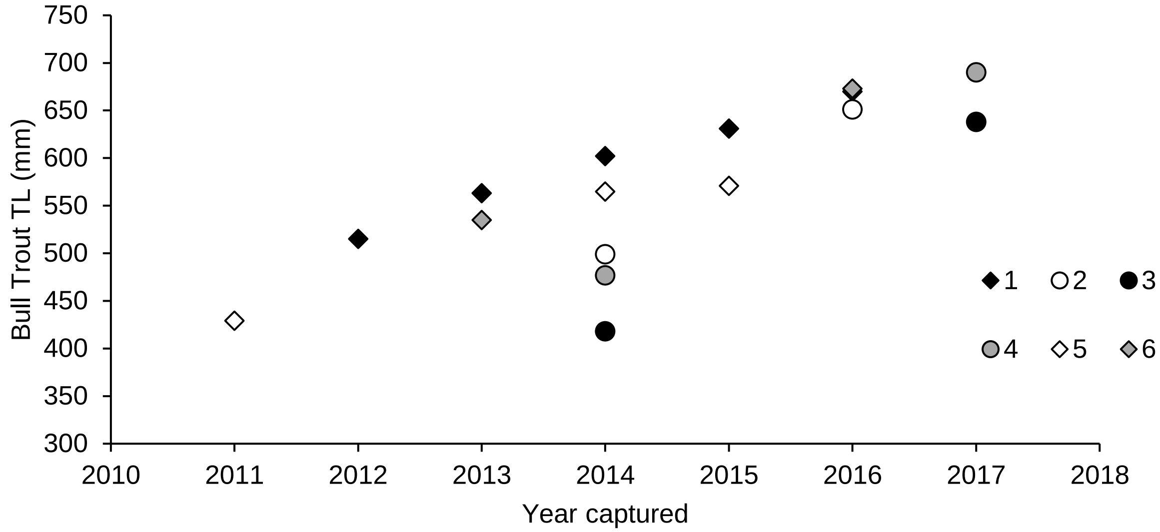

Figure 47. Total length (mm) at capture for fluvial Bull Trout (n = 6) that spawn in the East Fork Salmon River, and overwinter in the main stem Salmon River.

WILD TROUT REDD COUNTS

ABSTRACT

Regional fisheries staff conducted redd count surveys for resident Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* populations in 2017, as part of an annual trend monitoring program. In spring, we counted 98 Rainbow Trout redds in Big Springs Creek and 139 in the Lemhi River. During Bull Trout redd count surveys in fall 2017, we counted 12 redds in Alpine Creek, 14 in Fishhook Creek, 39 in Fourth of July Creek, 77 in Bear Valley Creek, and 43 redds in the main stem of Hayden Creek. Bull Trout redds were not enumerated in the East Fork Hayden Creek in 2017. Compared to surveys in 2016, the number of Rainbow Trout redds counted in the Lemhi River and Big Springs Creek in 2017 was very similar. The number of Bull Trout redds counted in 2017, compared to 2016, increased in Fourth of July Creek and Upper Hayden Creek, but decreased in all other transects.

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INTRODUCTION

Salmon Region IDFG staff conduct annual redd counts for resident and fluvial Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* in nine streams in the region, to monitor trends in spawner abundance. In 1994, we began counting Rainbow Trout redds in Big Springs Creek, a tributary to the upper Lemhi River near Leadore, and in 1997 another transect was established for Rainbow Trout on the upper Lemhi River, just above the confluence with Big Springs Creek. Redd count monitoring for Rainbow Trout on these transects provides a general indication of population abundance trends over time. Numerous habitat improvement projects, changes in water-use practices, alterations in land management practices, and fisheries regulation changes have occurred in the upper Lemhi River basin in the last two decades, all of which have likely benefited resident fish populations.

Bull Trout were listed as threatened under the Endangered Species Act (ESA) on June 10, 1998. That fall, we established the Salmon Region's first trend transects for enumerating Bull Trout redds. Trend transects were established on Alpine and Fishhook Creeks in the Sawtooth Basin, near Stanley in 1998, on Bear Valley Creek and East Fork Hayden Creek in the Lemhi River drainage in 2002, on Fourth of July Creek in the Stanley basin in 2003, and on Upper Hayden Creek in the Lemhi River drainage in 2006.

Over the years, as additional redd production areas have been located (outside of established transect boundaries), new trend transects have been added to encompass as much spawning production as possible. New transects were added to account for additional productivity on Bear Valley Creek in 2007, on Fishhook Creek in 2008, and on Alpine Creek in 2011. In upper Hayden Creek, the trend transect was moved altogether in 2010, when staff determined the existing transect was too low in the drainage and most Bull Trout spawning occurred much higher.

OBJECTIVES

1. Maintain trend monitoring datasets for spawning resident and fluvial trout in the region by continuing annual redd counts and operating fish weirs in priority tributaries.

STUDY SITES AND METHODS

Rainbow Trout Redd Count Monitoring

Big Springs Creek

Big Springs Creek is a tributary to the Lemhi River, located approximately 8 km north of Leadore, Idaho. Two trend transects (Tyler transect and Neibaur transect) are walked on Big Springs Creek annually (Messner et al, 2016; Appendix B). The Big Springs transects were the first resident/fluvial Rainbow Trout redd count trend transects established in the region in 1994.

Redd counts are usually conducted during the last week of April or the first week of May on Big Springs Creek. The counts are "single pass" counts, where redds are counted on a single occasion and are not flagged. Redd counts on Big Springs Creek were conducted on May 4 in 2017.

Lemhi River

The Lemhi River flows approximately 100 km from its headwaters near Leadore, Idaho to its confluence with the Salmon River at Salmon, Idaho. The upper Lemhi River redd count trend transect was established in 1997 and includes a 3-km section of Lemhi River flowing through the property known as the Merrill Beyeler Ranch from the fence line 100 meters upstream of the upper water gap to the lower fenced boundary (Messner et al, 2016; Appendix B).

Redd counts are usually conducted during the last week of April or the first week of May, at the same time and using the same methods as for Big Springs Creek (single pass). Redd counts on the Lemhi River were conducted on May 4, 2017.

Bull Trout Redd Count Monitoring

Alpine Creek

Alpine Creek is a tributary to Alturas Lake Creek, which flows into Alturas Lake in the Sawtooth basin, approximately 35 km south of Stanley, Idaho. Two trend transects are walked annually on Alpine Creek (Messner et al, 2016; Appendix B).

Historically, two visual ground counts are conducted annually, about two weeks apart, on both transects in Alpine Creek. However, only one count was conducted in 2017 due to insufficient time for completing both counts. The survey in 2017 was conducted on October 9 to account for as much spawning as possible. For each transect, all redds in progress or completed redds were counted during the survey.

Fishhook Creek

Fishhook Creek is a tributary of Redfish Lake in the Sawtooth basin, approximately 10 km south of Stanley, Idaho. Two trend transects are walked on Fishhook Creek annually (Messner et al, 2016; Appendix B).

Historically, two visual ground counts are conducted annually, about two weeks apart, on each of the two Fishhook Creek transects. Only one count was conducted in 2017 due to insufficient time for completing both counts. The survey on Fishhook Creek was conducted on October 10, 2017. For each transect, all redds in progress or completed redds were counted during the survey.

Fourth of July Creek

Fourth of July Creek is a tributary of the upper Salmon River in the Sawtooth basin, located approximately 28 km south of Stanley, Idaho. One single visual ground count is conducted on Fourth of July Creek annually (Messner et al, 2016; Appendix B).

Fisheries staff conducted a redd count survey for Bull Trout in Fourth of July Creek on September 7, 2017. Redd counts on Fourth of July Creek are “single pass” counts, meaning redds are enumerated on a single occasion and are not flagged.

Hayden Creek

Hayden Creek is the largest tributary to the Lemhi River. The trend transect currently surveyed on upper Hayden Creek (Appendix B) is not the same that was established in 2006. The older transect produced single digit Bull Trout redd counts each year between 2006 and 2009. In 2010, the transect boundaries were moved upstream to the current location (Messner et al, 2016) to encompass the bulk of spawning activity (M. Biggs, IDFG, personal communication).

Both fluvial and resident forms of Bull Trout are found in upper Hayden Creek. The upper Hayden Creek trend transect is walked twice annually, approximately one week apart, to visually count fluvial and resident Bull Trout redds. In 2017, five passes were conducted. Redd counts in 2017 were conducted on August 27, and September 5, 11, 18, and 27. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter while redds smaller in size were considered those of resident Bull Trout. For each transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second survey in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds

Bear Valley Creek

Bear Valley Creek is a tributary of Hayden Creek in the Lemhi River drainage, located approximately 60 km south of Salmon, Idaho. Two trend transects are walked annually on Bear Valley Creek to enumerate Bull Trout redds (Messner et al, 2016; Appendix B).

Two to three visual ground counts are conducted annually about one week apart on the Bear Valley Creek transects. A third pass is typically only conducted when the ratio of live fish to redds is greater than one on the second pass. In 2017, six counts were conducted on August 22 and 29, and September 6, 12, 20, and 28. Both fluvial and resident Bull Trout life histories are found in Bear Valley Creek. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter while redds that were smaller in size were considered those of resident Bull Trout. For each transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second and third passes in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds.

East Fork Hayden Creek

Bull Trout redd counts on East Fork Hayden Creek were not conducted in 2017 due to time constraints.

RESULTS AND DISCUSSION

<u>Rainbow Trout Redd Count Monitoring</u>

Big Springs Creek and Lemhi River

Fisheries staff observed 98 Rainbow Trout redds in Big Springs Creek and 139 Rainbow Trout redds in the upper Lemhi River in 2017, for a total of 237 redds (Table 22, Figure 48). On Big Springs Creek, 52 redds were counted in the historic Neibaur Ranch transect while 46 redds were observed in the Tyler Ranch transect (Table 22). The total number of redds counted in 2017 is only one redd different than the 2016 count, and both fall on the average trend count line (Figure 48). The 2012 to 2014 trend counts were three of the four highest counts on record, but spawner abundance decreased in 2015 and has remained relatively lower in 2016 and 2017. Numerous habitat improvement projects, tributary reconnections, and changes in land-use practices over the last several decades in the upper Lemhi River seem to have benefitted the resident Rainbow Trout population, as redd numbers increased from 1997 through the early 2000s. Since that time, redd numbers have fluctuated, with another peak in 2014, and likely reflect the response to varying natural conditions. Although the overall trend count in 2017 was on average relative to the past 10 years of data, the number of redds counted in the mainstem Lemhi River transect alone has increased (Figure 48). These transects will continue to be monitored annually.

Bull Trout Redd Count Monitoring

Alpine Creek

In the upper Alpine Creek trend transect, we did not encounter any Bull Trout redds in 2017 (Table 23, Figure 49). Prior to 2013, no Bull Trout redds, or live fish, had been observed in the upper trend area in five years. Numbers of redds observed in this transect has been low since then, but in 2017 we documented relatively recent beaver activity which seems to have increased spawning habitat quality in the lower end of the transect. Perhaps this will result in a greater number of redds in this transect in future years. In the lower trend transect (established in 2010), we observed 12 redds in 2017. 2016 was the first year we counted more than two Bull Trout redds in that reach since the transect was established (Figure 49). The greater number of redds observed in this transect in 2017 may be a result of spawning Bull Trout stopping farther downstream than they usually do, which also could be why no redds were observed in the upper transect. In total, the number of Bull Trout redds observed in Alpine Creek in 2017 was very similar to the total number of redds in 2016, both of which are an increase from 2008-2015 redd numbers (Figure 49).

Fishhook Creek

Twelve Bull Trout redds were observed in the upper trend transect in Fishhook Creek in 2016, and two redds were counted in the lower transect (Table 23, Figure 50). Redd abundances in the upper transect in 2015 and 2016 were the highest documented to date. Prior to 2015, Bull Trout redd numbers in Fishhook Creek have remained relatively consistent over the years, indicating a stable population, and the count for 2017 falls just slightly below average. The increase in spawner abundance in 2015 and 2016 may result in increased redd numbers in the near future if survival is good for those cohorts produced. Determining the age-structure of the spawning population of Bull Trout in this tributary (and others) could help provide insight on when we could expect to see peaks and valleys in the spawner abundance trend figures.

Fourth of July Creek

Staff counted 39 completed Bull Trout redds in the Fourth of July Creek trend transect in 2017 (Table 23, Figure 51). Based on a pattern that emerged in the data since we began monitoring redd abundance in 2003, we expected to see relatively high abundance of redds in Fourth of July Creek in 2016, but this was not the case. However, redd abundance in 2017 tracked similarly to what would be expected given the aforementioned trend (Figure 51). Based on that same trend, we expect 2018 to produce a relatively lower abundance of redds.

Hayden Creek

Forty-three Bull Trout redds were counted in the upper Hayden Creek trend site in 2017 (Table 24, Figure 52). Twenty-three redds were estimated to be fluvial size (53%) and 20 were resident size (47%), similar to the 56% to 44% breakdown observed in 2016, respectively.

Bear Valley Creek

Regional fisheries staff counted 24 Bull Trout redds in the older Bear Valley Creek trend transect in 2017 and 53 redds in the newer trend transect, for a total of 77 redds (Table 24, Figure 53). Thirty-nine redds were estimated as fluvial size (~50%) and 38 as resident size. In general, Bull Trout redd abundance has been relatively high in Bear Valley Creek over the past seven years.

East Fork Hayden Creek

Bull Trout redds were not counted in the East Fork of Hayden Creek in 2017.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring trends in spawner abundance for resident trout populations in designated trend transects.

2. Collect fluvial Bull Trout (either pre- or post-spawn) to implant PIT tags for further movement and growth study throughout the upper Salmon River basin.

3. Consider collecting fluvial Bull Trout fin rays to determine age structure of spawning groups.

Table 22. Summary of Rainbow Trout redds counted in the upper Lemhi River and Big Springs Creek (BSC) transects, 1994 – 2017.

Year	Big Springs Creek Neibaur Ranch	Big Springs Creek Tyler Ranch	Lemhi River Beyeler Ranch	Total
1994	--	--	--	40
1995	57	--	--	57
1996	32	--	7	39
1997	44	45	8	97
1998	93	124	18	235
1999	39	71	29	139
2000	160	123	23	306
2001	95	186	2	283
2002	360	193	3	556
2003	128	103	56	287
2004	174	45	15	234
2005	75	43	3	121
2006	63	143	9	215
2007	163	62	8	233
2008	82	108	9	199
2009	100	54	10	164
2010	132	57	18	207
2011	103	49	20	172
2012	130	224	14	368
2013	159	122	49	330
2014	185	280	93	558
2015	65	60	75	200
2016	124	66	46	236
2017	52	46	139	237

Table 23. Bull trout redds counted in tributaries of the upper Salmon River in the Sawtooth National Recreation Area, 1998 – 2017.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Alpine Creek	1998	1	--	1
	1999	3	--	3
	2000	9	--	9
	2001	15	--	15
	2002	14	--	14
	2003	14	--	14
	2004	9	--	9
	2005	13	--	13
	2006	13	--	13
	2007	18	--	18
	2008	0	--	0
	2009	0	--	0
	2010	0	1	1
	2011	0	2	2
	2012	0	0	0
	2013	1	2	3
	2014	4	0	4
	2015	3	0	3
	2016	6	7	13
	2017	0	12	12
Fishhook Creek	1998	11	--	11
	1999	15	--	15
	2000	18	--	18
	2001	26	--	26
	2002	17	--	17
	2003	17	--	17
	2004	11	--	11
	2005	23	--	23
	2006	25	--	25
	2007	22	--	22
	2008	13	14	27
	2009	21	12	33
	2010	17	10	27
	2011	11	7	18
	2012	21	9	30
	2013	15	13	28
	2014	6	8	14

Table 23 (continued)

Stream	Year	Older transect redds	Newer transect redds	Total redds
Fishhook Creek	2015	61	2	63
	2016	47	13	60
	2017	12	2	14
Fourth of July Creek	2003	16	--	16
	2004	33	--	33
	2005	41	--	41
	2006	71	--	71
	2007	49	--	49
	2008	25[a]	--	25[a]
	2009	50	--	50
	2010	56	--	56
	2011	51	--	51
	2012	50[a]	--	50[a]
	2013	21	--	21
	2014	85	--	85
	2015	48[a]	--	48[a]
	2016	8	--	8
	2017	39	--	39

[a] Numbers reported incorrectly in 2015 annual report

Table 24. Bull trout redds counted in the Hayden Creek drainage in the Lemhi River basin, 2002 – 2017.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Bear Valley Creek	2002	26	--	26
	2003	42	--	42
	2004	44	--	44
	2005	34	--	34
	2006	26	60	86
	2007	25	115	140
	2008	27	21	48
	2009	42	24	66
	2010	37	22	59
	2011	36	103	139
	2012	33	91	124
	2013	41	78	119
	2014	66	134	200
	2015	39	98	137
	2016	30	59	89
	2017	24	53	77
Hayden Creek	2005	22	--	22
	2006	74	--	74
	2007	115	--	115
	2008	28	--	28
	2009	22	--	22
	2010	--	29	29
	2011	--	49	49
	2012	--	39	39
	2013	--	14	14
	2014	--	29	29
	2015	--	18	18
	2016	--	41	41
	2017	--	43	43

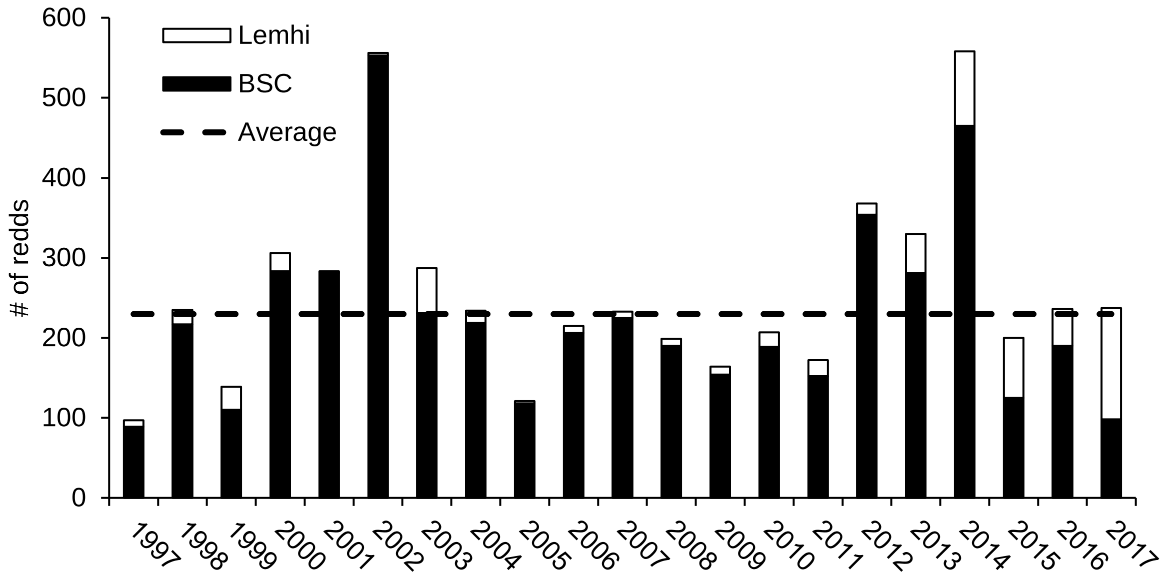

Figure 48. Resident Rainbow Trout redds counted during ground surveys in the upper Lemhi River (Beyeler Ranch) and Big Springs Creek (BSC) (Neibaur and Tyler ranches), 1997 – 2017.

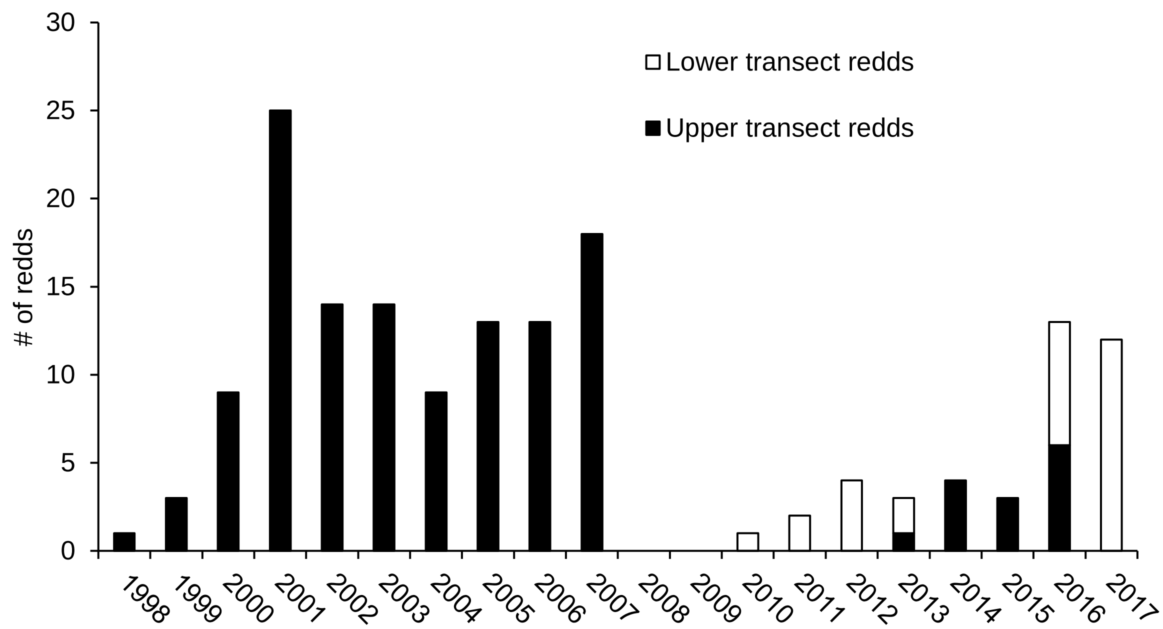

Figure 49. Number of Bull Trout redds counted in both survey transects on Alpine Creek, 1998 – 2017.

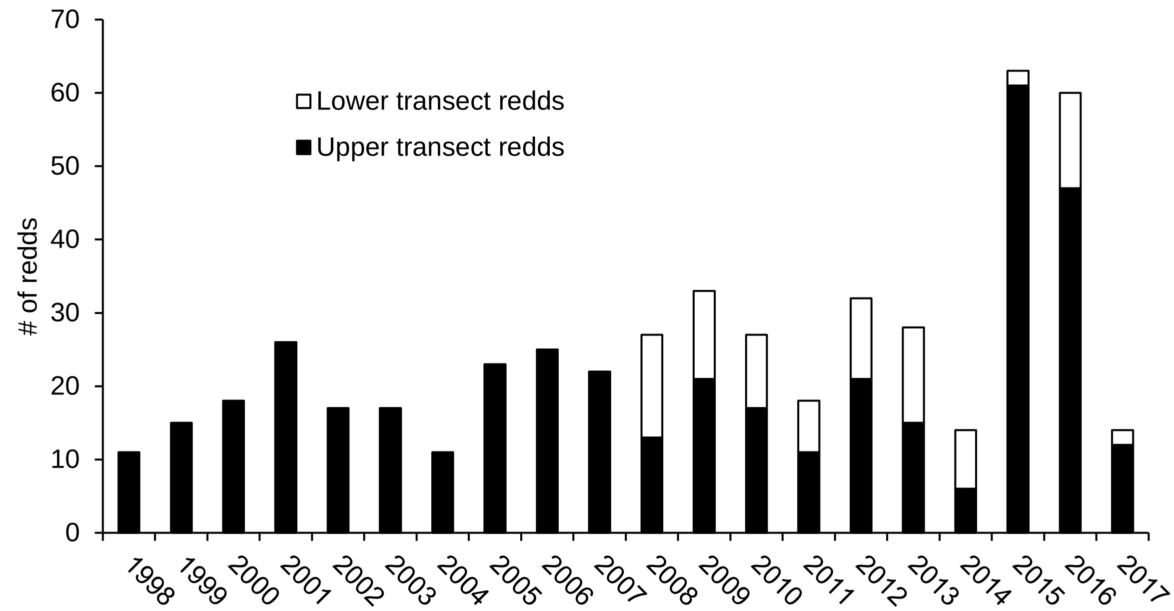

Figure 50. Number of Bull Trout redds counted in both transects on Fishhook Creek, 1998 – 2017.

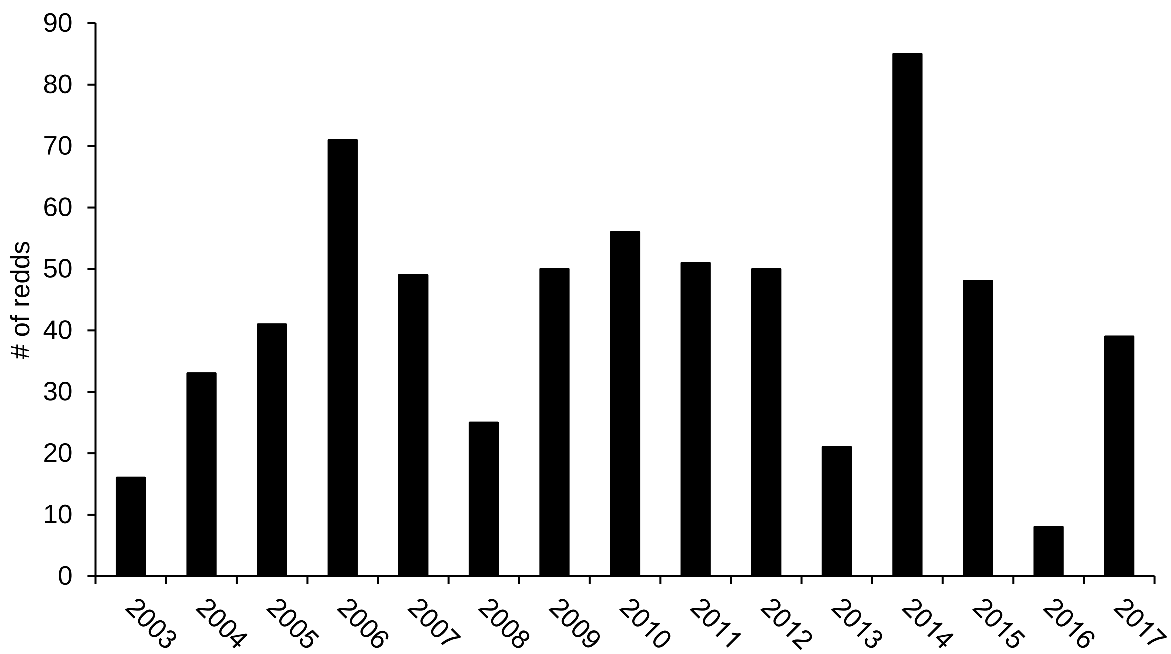

Figure 51. Number of Bull Trout redds counted on Fourth of July Creek, 2003 – 2017.

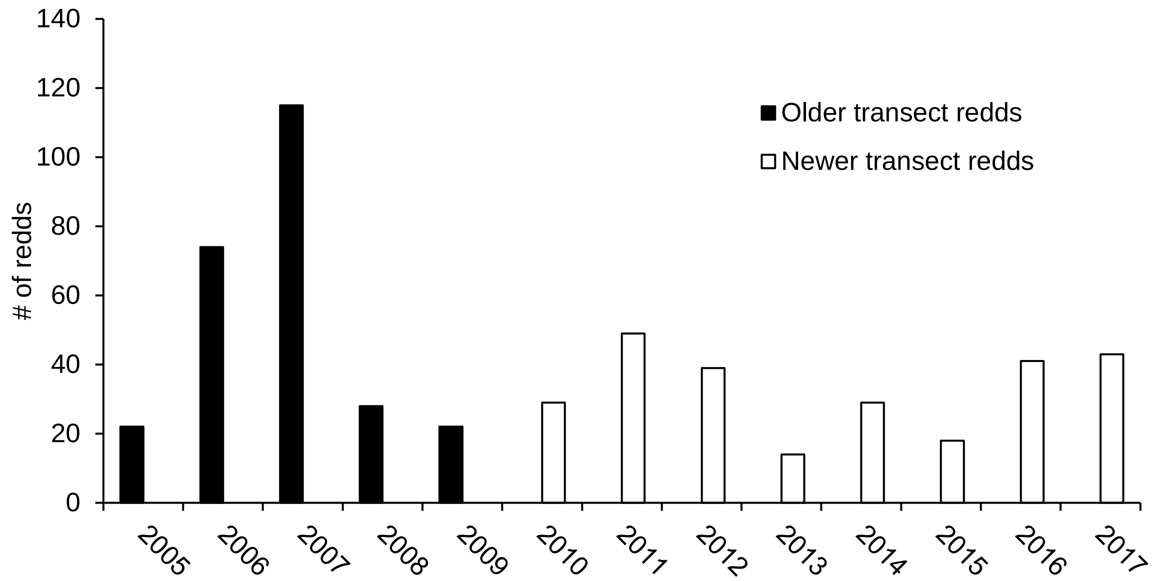

Figure 52. Number of Bull Trout redds observed in upper Hayden Creek redd count trend transect, 2005 – 2017.

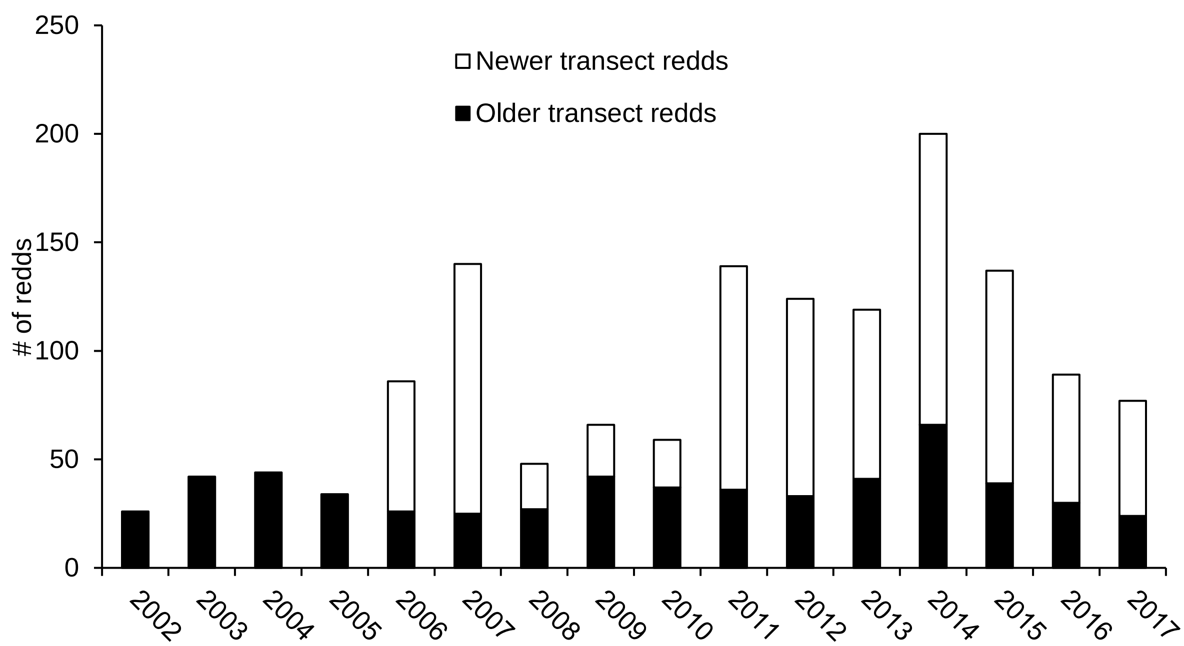

Figure 53. Number of Bull Trout redds observed in the Bear Valley Creek transects, 2002 – 2017.

PAHSIMEROI RIVER FLUVIAL RAINBOW TROUT

ABSTRACT

During the spring steelhead trapping season at the Pahsimeroi Hatchery in 2017, we captured 143 adult (> 300 mm) fluvial Rainbow Trout on their way up the Pahsimeroi River to spawn. This was the third highest fluvial Rainbow Trout escapement recorded at the Pahsimeroi River weir/fish trap since monitoring began in 1993. Upstream migrating fluvial Rainbow Trout were encountered immediately following the start of weir operation on February 20, and were captured up until April 20, 2017. Fluvial Rainbow Trout trapped at the weir in 2017 ranged in TL from 311 to 535 mm and averaged 413 mm. Sex composition was 74% female (*n* = 106) and 26% male (*n* = 37). Thirteen of these Rainbow Trout, averaging 435.5 mm TL (382 to 481 mm) and 722.8 g (522 to 1020 g), were radio tagged at the weir during the trapping period.

Radio-tagged fish movements were studied during and after their spawning migrations. Four of the 13 radio tagged fish (31%) did not move upstream from the release location, and were considered either mortalities or shed tags. The other nine radio-tagged Rainbow Trout (69%) migrated upstream from their release location and it is assumed that they spawned within the main stem Pahsimeroi River, below the confluence with Patterson Creek. Upstream migrations to likely spawning locations in the main stem Pahsimeroi River averaged 10.4 km (range, 5.1-17.2 km). Six tagged fish exhibited post-spawning downstream migration as early as March 20 and as late as May 20, an average of 55 days (range, 25-86 d) after being trapped and tagged at the weir.

After spawning, nine fluvial Rainbow Trout were collected as mortalities on the weir. All mortalities collected during this period were in post-spawn condition, and were aged using otoliths. Age estimates ranged from age-6 to age-9.

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INTRODUCTION

Idaho Department of Fish and Game's Pahsimeroi Fish Hatchery staff operate a fixed broodstock collection weir on the Pahsimeroi River, near the confluence with the Salmon River, in early spring each year to trap returning adult steelhead *Oncorhynchus mykiss* for spawning operations. During that time period, fluvial Rainbow Trout *O. mykiss,* which exhibit a migratory life history strategy consisting of movements into spawning tributaries in spring, and movements into the main stem Salmon River to overwinter, are also captured. In 1991, hatchery staff started recording the number of fluvial Rainbow Trout encountered at the weir during spring steelhead trapping season (February through April). From 1991 to 2009, an average of 43 fluvial Rainbow Trout were encountered at the weir each spring (range, 8-81). From 2010 to 2016 however, the average number of fluvial Rainbow Trout encountered at the weir each year increased threefold to 131 (66 to 266). The increase in abundance of spawning fluvial Rainbow Trout in the Pahsimeroi River coincided with a period during which several habitat improvement and screening improvement projects occurred, including the re-connection of approximately 21 km of suitable spawning habitat. Adult Chinook Salmon have been observed spawning in this newly reconnected habitat in recent years (IDFG unpublished data), but fluvial Rainbow Trout spawning locations are unknown. Unlike Chinook Salmon *O. tshawytscha* which spawn in the fall when flows are lower, Rainbow Trout and steelhead spawn in the spring when flows and turbidity are generally high, making streamside redd counts difficult. In order to document spawning locations for fluvial Rainbow Trout in the Pahsimeroi River in 2017, we conducted a radio-telemetry study and recorded fish movements throughout the spawning season.

OBJECTIVES

1. Enumerate and describe fluvial Rainbow Trout spawning escapement in spring 2017 in the Pahsimeroi River, using capture at the Pahsimeroi weir.

2. PIT tag all fluvial Rainbow Trout captured at the weir, and radio tag a representative sample (~10%, 50:50 sex ratio) throughout the migration period to observe spawning movements.

3. Determine likely spawning locations in the Pahsimeroi drainage, and continue tracking post-spawn movement.

STUDY SITE

The Pahsimeroi River is a tributary to the Salmon River, located approximately 25 km north of Challis, ID. The confluence of the Pahsimeroi River and the Salmon River (elevation 1,402 m) is located at Ellis, Idaho (WGS84 datum: 44.692285°N, -114.048556°W). The Pahsimeroi River valley is a broad alluvial valley confined by the Lemhi Mountain Range to the east (highest peak 3,334 m) and the Lost River Mountain Range to the west (highest peak 3,859 m). The highest elevation of the valley floor is 2,377 m, approximately 80 km from the river's confluence with the Salmon River. The Pahsimeroi River drainage is a sink basin that is heavily influenced by groundwater. Major tributaries of the Pahsimeroi River from the east include Morgan, Morse, Falls, Patterson, Big, and Goldburg creeks, and major tributaries from the west include Lawson, Sulphur, Meadow, Grouse, and Doublesprings creeks. Several tributaries of the

Pahsimeroi River are seasonally disconnected from the main stem Pahsimeroi River, in terms of surface flow, due to both natural (i.e. sink basin dynamics) and anthropogenic causes.

The Pahsimeroi Valley has a long history of hay production and livestock grazing dating back to the late 1800's and continuing today. Irrigation withdrawal from certain Pahsimeroi River tributaries dewatered the channel and resulted in the loss of critical spawning habitat for ESA-listed species (Chinook Salmon and steelhead) for decades. In recent years however, collaboration between private landowners, state and federal agencies, and non-profit groups has re-opened previously disconnected habitat that is now being utilized for spawning Chinook Salmon.

Salmonid species currently occupying the Pahisimeroi River drainage include Chinook Salmon and steelhead, Westslope Cutthroat Trout *O. clarkii,* Bull Trout *Salvelinus confluentus*, Brook Trout *S. fontinalis*, and both fluvial and resident life history forms of Rainbow Trout. The earliest IDFG records for Rainbow Trout stocking in the Pahsimeroi River drainage are in 1926, with stocking ending in 1968. Although records show all stocked Rainbow Trout were raised at IDFG's Mackay Fish Hatchery prior to stocking, records do not indicate the particular strain used. IDFG used a variety of egg sources for Rainbow Trout stocking at that time (eg. locally adapted wild broodstock at Williams Lake, or hatcheries such as Mt. Whitney, Mt. Lassen, and Shasta), and the exact source for Pahsimeroi River stocking events is unknown.

METHODS

Fluvial Rainbow Trout migrating upstream were captured in February through April 2017 at the Pahsimeroi River Fish Hatchery weir during adult steelhead broodstock collection operations. The weir is located approximately 1.5 km upstream from the confluence with the Salmon River, at 44.684474°N, -114.040360°W (WGS84 datum), and was operated from February 20 through May 1, in 2017. All fluvial Rainbow Trout captured at the weir were measured (TL mm), scanned for Passive Integrated Transponder (PIT) tags, given a PIT tag if none was detected, and a genetic sample was taken for later evaluation of strain origin.

A subsample of the spawning population was surgically implanted with a radio transmitter (LOTEK MCFT2-3EM, operating at 150.780 MHz, battery life: 528 days) to observe movement patterns throughout the spawning season. Radio Transmitters weighed 10 g and emitted a signal once every 5 seconds. Tags were set to emit a mortality code if they remained motionless for a 24hr period. Fish that were radio-tagged were weighed in order to ensure tag weight was no more than 2% body weight. All radio-tagged Rainbow Trout were anaesthetized in a solution of tricaine methanesulfonate (MS-222) before tagging. To ensure fish remained under anesthesia during surgery, fish were placed in a V-shaped holding tray and their gills were irrigated with the MS-222 solution using a battery operated pump. Radio transmitters were implanted using a surgical procedure similar to that described by Ross and Kleiner (1982).

Radio-tagged fish were located once or twice per week by vehicle, or in some cases by foot, using a LOTEK model SRX_400 radio telemetry receiver. Tracking on foot was performed twice during the study period, and kayaks were used for mobile-tracking once, in order to determine whether fish were actively spawning and to look for redds. When fish were located, their approximate position was marked using a handheld Garmin GPS unit. Likely spawning locations were identified as the most upstream location where fish spent several days.

Throughout the study period, Pahsimeroi Fish Hatchery staff collected any Rainbow Trout mortalities they encountered while cleaning debris off of the weir. These mortalities were scanned for PIT and radio tags, measured (TL mm), weighed (g), and examined internally to determine whether or not they had spawned. Additionally, we collected otoliths and a pectoral fin ray sample from Rainbow Trout mortalities to determine the age-structure of the spawning population.

RESULTS

One-hundred and forty-three (143) adult (> 300 mm) fluvial Rainbow Trout were captured at the Pahsimeroi Hatchery weir during steelhead trapping operations in spring, 2017; the third highest return since monitoring began in 1993 (Figure 54). Upstream migrating fluvial Rainbow Trout were encountered immediately following the start of weir operation on February 20, and were captured up until April 20, 2017 (Figure 55). Fluvial Rainbow Trout trapped at the weir in 2017 ranged from 311 to 535 mm and averaged 413.1 mm (Table 25, Figure 56). Sex composition was 74% female (*n* = 106) and 26% male (*n* = 37). Thirteen of these Rainbow Trout, averaging 435.5 mm (382 to 481 mm) and 722.8 g (522 to 1,020 g), were radio tagged at the weir during the trapping period (Tables 25 and 26).

Radio tagged fish movements were studied during and after their spawning migrations. Four of the 13 radio tagged fish (31%; tag codes 89, 90, 96, and 98) did not move upstream from the release location, and were considered either mortalities or shed tags. Tag code 98 showed a mortality signal immediately following tagging, and was later recovered on the bank with bite marks on the antenna (possible predation). Tag codes 90 and 89 showed mortality signals 9 and 29 days, respectively, after tagging and both carcasses were recovered on the weir immediately following detection of the mortality code. Tag code 96 never showed a mortality code, but did not move until 37 d after tagging, when it was found below the weir, suggesting it was a shed tag that drifted through the weir pickets. It was later recovered below high water line, downstream in the Salmon River. The other nine radio-tagged Rainbow Trout (69%) migrated upstream from their release location and it is assumed that they spawned within the main stem Pahsimeroi River, below the confluence with Patterson Creek (Figure 57). Upstream migrations to likely spawning locations in the main stem Pahsimeroi River averaged 10.4 km (range, 5.1-17.2 km; Table 26).

Six tagged fish (tag codes 88, 91, 93, 94, 97, and 99) exhibited post-spawning downstream migration between March 20 and May 20, an average of 55 days (range, 25-86 d) after entering the Pahsimeroi River (Table 26). Tag code 95 was collected near a redd and was likely preyed upon (the tag was recovered on the bank and had been chewed on), therefore it did not exhibit a post-spawning migration. Six of the remaining tagged fish migrated downstream soon after spawning (Table 26). Three tagged fish (tag codes 94, 97, and 99) migrated downstream (after spawning) prior to the Pahsimeroi weir being opened on May 1, and remained within 0.5 km above the Pahsimeroi weir for an average of 19.6 d (range, 9-41 d) before the weir was opened (Table 26). During the period that these fish were gathered above the weir, tag code 94 began showing a mortality code, and tag code 97 was collected as a mortality on the weir, in addition to seven other non-radio tagged fluvial Rainbow Trout that had been PIT tagged during their upstream spawning migration. Tag code 93 was collected as a mortality on the weir on May 2, the day after the weir was opened. There were nine confirmed mortalities in 2017, suggesting minimum post-spawn mortality was 6%. All mortalities collected during this period (*n* = 9) had spawned prior to death, and were aged using otoliths. Age estimates ranged between 6-9 years (Figure 58). Tag codes 92 and 100 remained in the Pahsimeroi River near their spawning locations until May 20, when they outmigrated from the Pahsimeroi River to the Salmon River.

We detected mortality signals on all radio tagged fish that outmigrated from the Pahsimeroi River by August, 2017, suggesting they shed their tags or ended up as mortalities (Table 26).

DISCUSSION

In general, fluvial Rainbow Trout entered the Pahsimeroi River earlier than steelhead in 2017. Approximately 50% of returning fluvial Rainbow Trout were trapped by March 14, at which time approximately 20% of the natural-origin steelhead had been trapped (Figure 55). After navigating the main stem Pahsimeroi River with kayaks during the spawning period, we recognized there is abundant quality spawning habitat within the Pahsimeroi River below the confluence with Patterson Creek, and this is likely where the majority of fluvial Rainbow Trout spawned in 2017. No radio tagged fish were observed above the confluence of the Pahsimeroi River and Patterson Creek in 2017. The section of the main stem Pahsimeroi where spawning likely occurred is highly braided and sinuous with deep holding pools, abundant riparian cover, and coarse spawning gravels at the back end of each pool; highly suitable for successful spawning of both Rainbow Trout and adult steelhead. Interestingly, only 14 natural-origin female steelhead and five natural-origin male steelhead were passed above the Pahsimeroi weir during the trapping period in 2017, so fluvial Rainbow Trout (n = 143) made up the majority of *O. mykiss* spawning in the Pahsimeroi River in 2017. Although it was not utilized by radio tagged fish, additional spawning habitat is also available higher in the system, in tributaries like Patterson Creek. We may see fluvial Rainbow Trout utilizing that habitat for spawning in future years, especially if spawning escapement increases further.

Ten of the 143 fluvial Rainbow Trout captured at the Pahsimeroi weir in 2017 had previously been PIT tagged prior to capture at the weir. Two were tagged as emigrating juveniles at the Pahsimeroi River screw trap in 2014 (n = 1) and 2015 (n = 1), both at 241 mm TL, and the other eight were tagged in the main stem Salmon River during either angling surveys in June 2016 (n = 2) or during raft electrofishing surveys in September or October 2016 (n = 6). PIT tagged Rainbow Trout tagged in the fall 2016 during electrofishing surveys, and recaptured at the weir in the spring 2017 grew an average of 6 mm (3 to 8 mm, n = 5) since they were tagged. PIT tagged Rainbow Trout tagged in June 2016 during angling surveys and recaptured at the weir in the spring grew an average of 39 mm (38 to 39 mm, n = 2) since they were tagged. Five (62.5%) of the eight fluvial Rainbow Trout PIT tagged in the main stem Salmon River in 2016 were tagged within 15 km of the mouth of the Pahsimeroi River, one was tagged approximately 25 km downstream of the mouth, one was tagged approximately 35 km downstream of the mouth, and one was tagged as far as 90 km downstream of the mouth.

The two Rainbow Trout captured at the weir in 2017 that had been PIT tagged as juveniles in 2014 and 2015 were likely somewhere around 5 or 6 years old in 2017 if they outmigrated as age-3 fish; the maximum age that was observed for outmigrating juvenile *O. mykiss* at the Pahsimeroi River screw trap in 2016 (IDFG unpublished data). Based on the estimated age structure of our sample of spawners collected in 2017 (Figure 58), age-6 appears to be the minimum age when these fluvial Rainbow Trout return to spawn, while age-9 was the maximum observed. However, we are unsure how many times an individual spawns in its lifetime. Pahsimeroi Hatchery staff have never detected any PIT tagged Rainbow Trout returning to spawn more than once (Morgan Fife, IDFG - *personal communication*), but until we PIT tagged 120 fluvial Rainbow Trout at the weir in spring 2017, only 12 fluvial Rainbow Trout PIT tags had ever been encountered at the hatchery. Increasing our tagging efforts and monitoring this population over the next few years will provide more information on repeat spawning behavior, annual growth and survival, and trends in abundance.

We observed a minimum estimated post-spawn mortality rate of 6% in 2017, based on collecting nine (of 143) mortalities at the weir. We only collected mortalities that had been pinned against the weir, and with additional mortalities likely, we consider this estimate of post-spawn mortality a ‘minimum estimate’. We may be able to improve our post-spawn mortality estimates for this population as we tag more fish in future years. Operating a PIT tag array at the mouth of the Pahsimeroi River to interrogate tagged fish as they exit the system may aid in improving these estimates. For comparison, other studies have found that fluvial Cutthroat Trout post-spawn mortality rates are somewhere in the range of 10-38% (Homel et al. 2015; Schmetterling 2001). Actual post-spawn mortality rates for the Pahsimeroi Rainbow Trout population are likely somewhere in this range.

Large fluvial Rainbow Trout have the potential to provide a high quality fishery for both the Pahsimeroi River and the main stem Salmon River throughout different periods of the year for anglers in the Salmon Region. As we learn more about this particular population of fluvial Rainbow Trout in the Pahsimeroi River, information may help us boost production and improve fishing in the area. Further studies should focus on repeat-spawning behavior, annual growth and survival, and abundance trends. Additionally, we may consider whether these fish could be used as a broodstock source to generate more fluvial Rainbow Trout production within the Pahsimeroi, or in other main stem Salmon River tributaries throughout the region.

MANAGEMENT RECOMMENDATIONS

1. Continue working with Pahsimeroi Hatchery staff to PIT tag fluvial Rainbow Trout as they are encountered at the weir, along with collecting biological information on those fish.

2. Acquire remote PIT tag array equipment to monitor Rainbow Trout downstream migration after spawning in the Pahsimeroi River.

Table 25. Summary statistics for all fluvial Rainbow Trout (RBT) captured at the Pahsimeroi River weir in spring 2017, as well as all fluvial Rainbow Trout radio tagged for this study. Fish that were not tagged for this study were not weighed.

	Mean TL (mm) (range)	Mean weight (g) (range)
Radio tagged RBT	435.5 (382-481)	722.8 (522-1020)
All RBT captured	413.1 (311-535)	--

Table 26. Radio tag codes, dates tagged, total length (TL), weight (Wt), Sex, and PIT tag codes for fluvial Rainbow Trout captured and radio tagged at the Pahsimeroi Hatchery weir in spring, 2017.

Radio tag code	Date tagged	TL (mm)	Wt (g)	Sex	PIT tag code	Upstream distance travelled (km)	# days to downstream movement	# days spent just above weir	Final disposition
100	2/23/2017	481	1020	M	3DD.00778CD921	12.66	86	0	Mort signal on 6/23/17 @ Salmon
99	2/23/2017	450	872	M	3DD.00778C0633	5.07	58	9	Mort signal on 6/9/17 @ Kilpatrick
98	2/23/2017	413	692	F	3DD.00778C5460	--	--	--	Mort signal on 2/27/17 @ weir
97	2/23/2017	430	772	F	3DD.003BF196BE	8.98	25	41	Post-spawn mortality on 5/1/17
96	2/23/2017	406	636	F	3DD.00778D02C0	--	--	--	Mort signal on 2/27/17 @ weir
95	3/6/2017	421	854	F	3DD.00778CAD9E	17.18	--	--	Predation mortality recovered on 3/27/17
94	3/6/2017	435	802	F	3DD.0077804E26	12.93	47	9	Mort signal on 4/22/17 @ weir
93	3/6/2017	382	522	M	3DD.00778C092D	5.39	57	0	Mort signal on 5/2/17 @ weir
92	3/9/2017	409	656	M	3DD.003BF19685	14.21	72	0	Mort signal on 8/16/17 @ Colston
91	3/9/2017	466	948	M	3DD.00778CF35C	9.23	60	0	Mort signal on 8/16/17 @ Cow Cr
90	3/23/2017	481	988	F	3DD.00778CBBF5	--	--	--	Pre-spawn mortality on 4/5/17
89	3/23/2017	446	792	F	3DD.00778D039D	--	--	--	Pre-spawn mortality on 4/25/17
88	3/23/2017	441	760	M	3DD.00778BEBA5	8.17	40	0	Mort signal on 7/18/17 @ Ellis

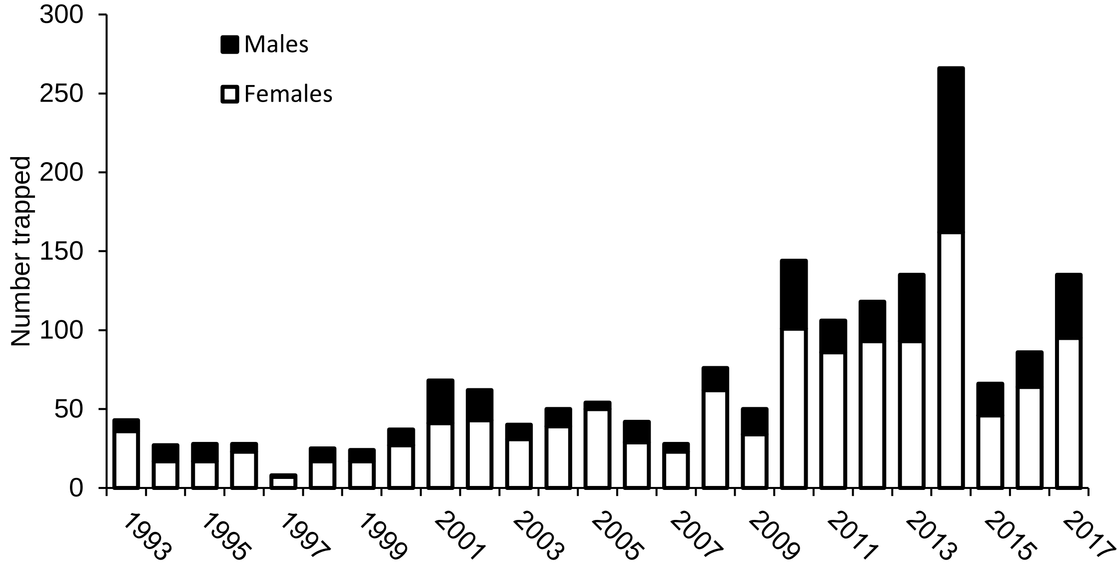

Figure 54. Number of fluvial Rainbow Trout trapped at the Pahsimeroi Hatchery weir during spring steelhead operation, 1993 to 2017.

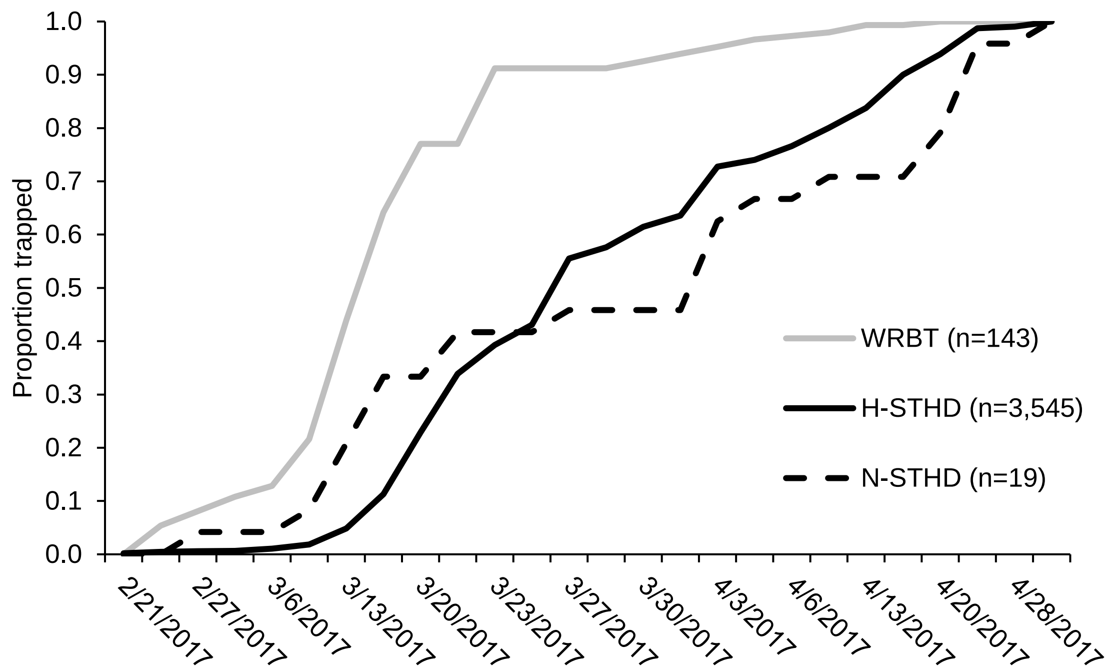

Figure 55. Run timing for fluvial Rainbow Trout (WRBT) trapped at the Pahsimeroi Hatchery weir during the spring trapping period in 2017 (2/20/17 to 5/1/17), compared to hatchery-origin steelhead (H-STHD) and natural-origin steelhead (N-STHD).

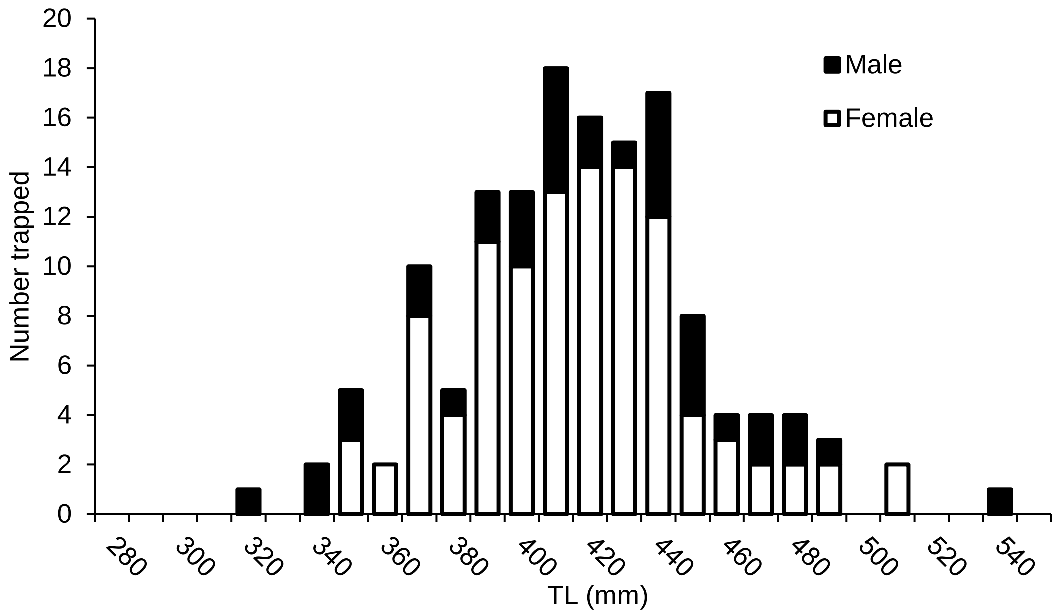

Figure 56. Length-frequency histogram for adult fluvial Rainbow Trout (>300 mm TL) trapped at the Pahsimeroi Hatchery weir between February 20 and April 20, 2017 (n = 143).

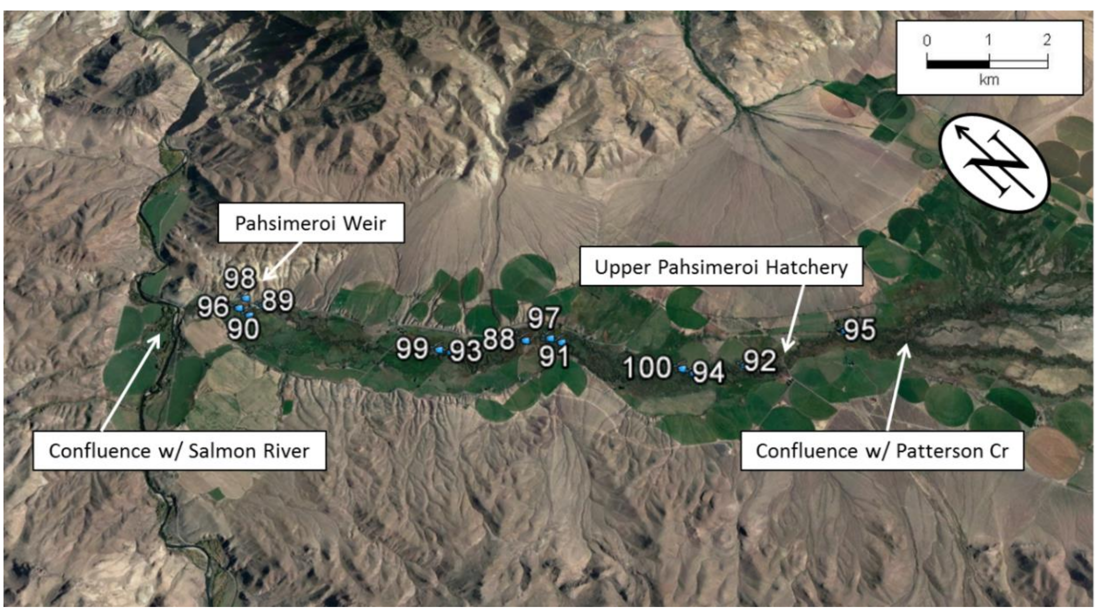

Figure 57 Farthest upstream locations radio tagged fish were found during the tracking period. These locations are thought to be where fluvial Rainbow Trout spawned during the study. A redd was confirmed for tag code 95. Tag codes 89, 90, 96, and 98 did not move upstream, and were considered mortalities or shed tags.

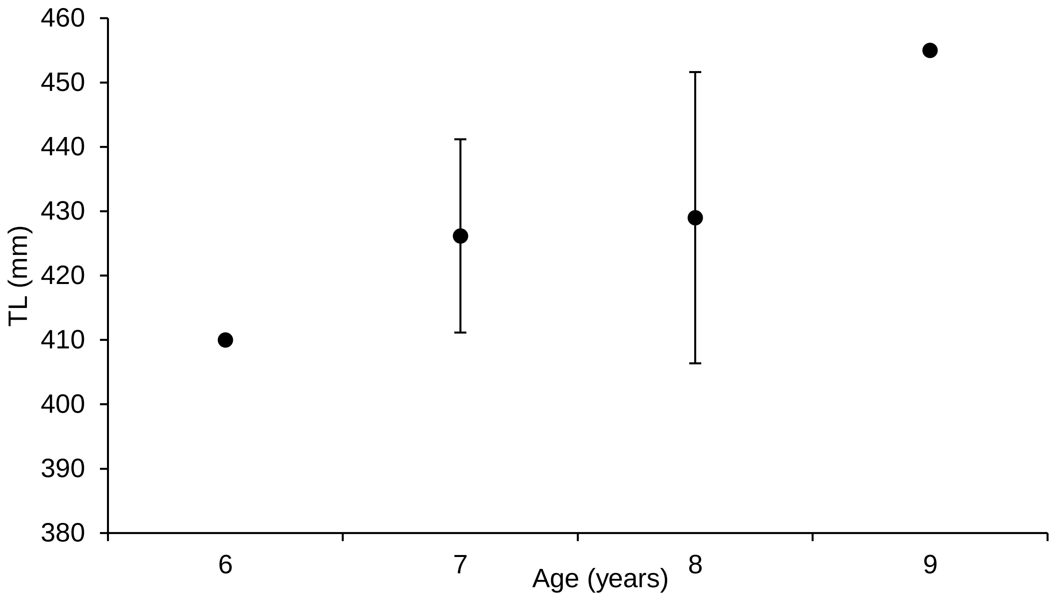

Figure 58. Mean total length (TL) at age (± SE) for fluvial Rainbow Trout post-spawn mortalities collected in 2017, based on otoliths (*n* = 9).

MIDDLE FORK SALMON RIVER TREND MONITORING

ABSTRACT

During July 2017, IDFG personnel snorkeled 41 trend transects in the Middle Fork Salmon River (MFSR) drainage to determine fish species composition, size, abundance, and density. Thirty-one main stem Middle Fork Salmon River (MFSR) transects and ten tributary transects were snorkeled. Salmonid densities observed in 2017 are among the highest we have observed since trend monitoring began. For main stem transects (both Corley and Traditional, combined) (n = 31), Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* had an overall mean density (± SE) of 2.51 fish/100 m^2 (± 0.51), Rainbow Trout/steelhead *O. mykiss* mean density was 1.69 fish/100 m^2 (± 0.52), and juvenile Chinook Salmon *O. tshawytscha* mean density was 8.45 fish/100 m^2 (± 2.60). In tributary transects (n = 10), Westslope Cutthroat Trout had an overall mean density of 0.44 fish/100 m^2 (± 0.10), Rainbow Trout/steelhead mean density was 1.71 fish/100 m^2 (± 0.43), and juvenile Chinook Salmon mean density was 5.66 fish/100 m^2 (± 1.10).

In 2017, 32% (n = 128) of the 398 Westslope Cutthroat Trout observed during main stem snorkel surveys were greater than 300 mm TL, compared to 13% in 1971 (prior to catch-and-release regulations implemented in 1972). Thirty percent (30%) of Westslope Cutthroat Trout caught during angling surveys in 2017 were greater than 300 mm TL. That number has fluctuated from a low of 25% in 2007 to 53% in 1987, but has remained higher in the years since catch-and-release regulations began (1972) than during the four years of data we have prior. Average angler catch rate during surveys has remained relatively stable over the last seven years (2.8 to 5.8 fish/h) and was 3.5 fish/h in 2017. Westslope Cutthroat Trout accounted for 57% of the total angler catch and Rainbow Trout/Steelhead accounted for 38% in 2017.

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INTRODUCTION

The earliest fishery study conducted on the Middle Fork Salmon River (MFSR) was a tagging study that took place in 1959 and 1960. That study evaluated seasonal movement, age and growth structure, and mortality of Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, to determine the impacts of a rapidly increasing recreational fishery (Mallet 1961, 1963). The study concluded that Westslope Cutthroat Trout in the MFSR could experience major declines due to year-round fishing pressure, and recommended to decrease the daily bag limit. Eventually catch-and-release regulations were adopted in 1972, and IDFG began monitoring abundance and size structure of MFSR Westslope Cutthroat Trout to evaluate the effectiveness of the new rules.

A 1971 study established snorkeling transects to be surveyed periodically in the MFSR drainage for monitoring fish population trends (Corley 1972; Jeppson and Ball 1977, 1979). In the 1971 report, these transects are described as main stem historical (Corley) transects (n = 6). In 1981, additional main stem transects were established in order to monitor steelhead *O. mykiss* populations on the MFSR (Thurow 1982, 1983, 1985). In 1985, the Department added additional snorkel sites to monitor trends in abundance of steelhead, juvenile Chinook Salmon *O. tshawytscha*, and Westslope Cutthroat Trout densities throughout the main stem and its tributaries (Reingold and Davis 1987; Lukens and Davis 1989; Davis et al. 1992; Schrader and Lukens 1992; Liter and Lukens 1994). The snorkel sites established in 1981 are known in this report as traditional main stem (n = 28) or traditional tributary (n = 10) transects. The Salmon Region has been snorkeling trend sites since 1971 and has been periodically monitoring trends in fish species composition and size structure caught during angling surveys in the MFSR since 1959. In 2008, we began recording fishing effort during angling surveys to monitor trends in catch rates.

OBJECTIVES

1. Monitor Rainbow Trout/steelhead, juvenile Chinook Salmon, and Westslope Cutthroat Trout densities within the MFSR and its tributaries to evaluate long-term trends in population status.

2. Monitor angling catch rates, particularly for Westslope Cutthroat Trout, to evaluate long-term trends of relative abundance.

STUDY SITES AND METHODS

The Middle Fork Salmon River (MFSR) is part of the Wild and Scenic Rivers System and flows through the Frank Church River of No Return Wilderness in central Idaho. The MFSR originates at the confluence of Bear Valley and Marsh creeks near Cape Horn Mountain. It flows 171 km to its confluence with the Salmon River, 92 km downstream from Salmon, Idaho. The MFSR is a major recreational river offering a wide variety of outdoor and back-country experiences. The number of people floating the river has increased substantially in the past 50 years, from 625 in 1962 to 11,528 in 2016. The U.S. Forest Service estimated total use days during the 2016 permit season on the MFSR (May 28-Sept. 3) to be 37,631 days (USFS website).

Main stem and Tributary Snorkeling Transects

MFSR snorkeling transects were sampled using techniques described by Thurow (1982). Snorkeling was conducted by two snorkelers floating downstream with the current, remaining as motionless as possible, along both sides of the river margin. All species observed were documented, and length and abundance were estimated for all salmonids. The area surveyed was estimated by multiplying the length snorkeled by the visible corridor (i.e. visibility). Visibility was measured at each site by suspending a sighting object in the water column and allowing the snorkeler to drift downriver until the object was unidentifiable. The snorkeler then moved upriver until the object reappeared clearly. The measured distance (m) between the object and the observer's facemask was the visibility. Fish densities were calculated by dividing estimated abundance by the area of the transect.

Historical transects on the main stem MFSR were established prior to 1985 while traditional transects were established after 1985. All six MFSR historical (Corley) transects, 25 of 28 traditional main stem transects, and all 10 traditional tributary transects were snorkeled during July 28 and August 1, 2017. Three traditional main stem transects were not snorkeled due to poor visibility on July 29.

Project Angling

The main objective of 'project angling' is to evaluate current trends in angler catch rates and trout size distribution. Project anglers used typical fly-fishing and spinning tackle to gather catch rate and size distribution information on 152.5 km of the main stem MFSR from Boundary Creek to the confluence with the Salmon River in 2017. Anglers recorded the exact amount of time fished, gear type used, total length and species of their catch. These data were added to an existing trend dataset that has been sporadically maintained since 1959, and consistently maintained since 2008.

Lamprey Sampling

We sampled 17 sandy beach sites on the main stem MFSR in 2017 to look for Pacific Lamprey *Entosphenus tridentatus* ammocoetes. Survey sites were chosen opportunistically based on visual observation of sandy habitat. Sites were electrofished using a Smith-Root LR-24 backpack shocker, with pre-programmed settings for 'preset 8' (at 11 sites). Preset 8 uses a burst of 3 pulses at 500 Hz, with 50% duty cycle and 30 Hz frequency at 100 volts and 400 watts of power. At Elk Bar (coordinates in Table 30), settings were changed for the remainder of sites (n = 6), to a dual frequency waveform. The dual frequency waveform uses two separate alternating settings. The first setting was 15 Hz frequency, 25% duty cycle, and 100 volts, and the second setting was 60 Hz frequency, 25% duty cycle, and 200 volts. All Lamprey captured were enumerated and measured to the nearest mm TL.

RESULTS AND DISCUSSION

Main stem and Tributary Snorkeling Transects

Mean densities (± SE) at traditional main stem sites in 2017 were 2.43 fish/100 m^2 (± 0.58) for Westslope Cutthroat Trout, 2.08 fish/100 m^2 (± 0.62) for Rainbow Trout/steelhead, 9.08

fish/100 m^2 (± 3.14) for Chinook Salmon parr, 0.04 fish/100 m^2 (± 0.03) for Bull Trout, and 2.66 fish/100 m^2 (± 0.62) for Mountain Whitefish (Table 27). Mean fish densities at historical main stem (Corley) sites snorkeled in 2017 were 2.84 fish/100 m^2 (± 1.18) for Cutthroat Trout, 0.06 fish/100 m^2 (± 0.06) for Rainbow Trout/steelhead, 5.83 fish/100 m^2 (± 3.82) for Chinook Salmon parr, and 1.86 fish/100 m^2 (± 0.81) for Mountain Whitefish (Table 27). In the ten traditional tributary transects we snorkeled in 2017, densities averaged 0.44 fish/100 m^2 (± 0.10) for Westslope Cutthroat Trout, 1.71 fish/100 m^2 (± 0.43) for Rainbow Trout/steelhead, 5.66 fish/100 m^2 (± 1.10) for Chinook Salmon parr, 0.05 fish/100 m^2 (± 0.02) for Bull Trout, and 1.02 fish/100 m^2 (± 0.19) for Mountain Whitefish (Table 27).

For anadromous parr in traditional main stem transects, snorkel densities in 2017 were surprisingly high considering the recent period of relatively low spawner escapement in the basin (Russ Thurow, USFS – unpublished data). Mean densities for Chinook Salmon parr and Rainbow Trout/steelhead across all main stem traditional sites in 2017 were among the highest values observed since 1985 (Figure 59). Upon further examination of individual years in the trend dataset, mean Chinook density in 2017 is the highest value we have observed for a year in which all main stem sites were snorkeled. In 2004 for instance, (the highest mean Chinook density on record: > 30 fish/100 m^2) only sites above Marble Creek were snorkeled, which led to inflated overall mean densities because sites in the upper end of the river tend to have much higher salmonid densities than sites in the lower end in most years (Figure 60). Anadromous parr may have been more abundant in the main stem MFSR in 2017 due to the high spring runoff event in 2017 (Figure 61). MFSR headwater tributaries that were snorkeled in 2017 on the other hand (not on this trip; eg. Marsh Creek), showed relatively lower Chinook parr densities than have been observed in recent years (IDFG unpublished data).

Westslope Cutthroat Trout snorkel densities in traditional main stem and tributary MFSR sites in 2017 on the other hand, were relatively average (Figure 59). Catch-and-release regulations on the main stem MFSR, which have been in effect since 1972, have reduced fishing mortality and led to relatively stable long-term populations. Catch-and release regulations have also helped improve the size distribution of Westslope Cutthroat Trout in the main stem MFSR. Prior to catch-and-release regulations, in 1971, the percent of Cutthroat Trout greater than 300 mm TL observed during snorkel surveys was 13%. That figure has ranged from 13% to 60% since that time. In 2017, 32% (*n* = 128) of the 398 Cutthroat Trout observed during snorkeling were estimated to be greater than 300 mm TL in main stem MFSR transects (Figure 62).

Project Angling

IDFG anglers caught 364 fish from the mainstem MFSR during angling surveys in 2017 (Table 28). Westslope Cutthroat Trout accounted for 57% of our total catch (*n* = 247) while Rainbow Trout/steelhead accounted for 38% (*n* = 99; Table 29, Figure 63). Mountain Whitefish, Northern Pikeminnow *Ptychochelius oregonensis*, suckers (various spp), Redside Shiner *Richardsonius balteatus*, Bull Trout, Chinook Salmon smolts, and trout hybrids accounted for the remaining 5% (Table 29, Figure 63). Angler catch per unit effort (CPUE) was 3.5 fish/h in 2017 (Table 28, Figure 64). CPUE has fluctuated between 2.8 fish/hour and 5.8 fish/hour since 2009 when we began recording angling effort times (mean 3.9 fish/h). Anglers do not always record water conditions during these surveys, but in 2017 it was noted that the river was cloudy on 7/29, and this likely affected the success of angling that day (Figure 65). Angling CPUE for 7/29 was very low (0.33 fish/h), and if that day were removed from the total average CPUE for the trip in 2017 due to poor angling conditions, average catch rate would be 4.1 fish/h. This highlights the importance of documenting metadata such as water conditions during these surveys. Our ability to detect dramatic shifts in species composition and fish abundance in the MFSR will increase as we continue to collect this data.

Prior to catch-and-release regulations going into effect in 1972, proportion of Westslope Cutthroat Trout caught by project anglers greater than 300 mm TL averaged approximately 20%. Since the regulation change, this proportion has fluctuated annually, ranging from a low of 25% in 2007 to a high of 53% in 1987 (mean 38.5%; Figure 66). In 2017, the proportion of Westslope Cutthroat Trout larger than 300 mm TL caught by project anglers was 30% (*n* = 74; Figures 66 and 67). Annual fluctuation of this value could be partially attributed to differences in angler skill level, gear type, sample timing, river discharge, and water clarity. However, in relative terms, this value has remained stable since 2010 (Figure 66).

The relative increase in proportion of larger Westslope Cutthroat caught since catch-and-release regulations went in place can be attributed mainly to reduced total annual mortality (particularly angling-related mortality) and higher abundance for Westslope Cutthroat Trout. Growth rates for WCT have actually decreased since the period prior to catch-and-release regulations (Messner et al. 2017). However, more WCT are living to maximum age (~7 years) than prior to the regulation change. Prior to the change, mean annual survival was estimated at 32% (1959-1960; Mallet 1963), and in 2015 we estimated mean annual survival at 60% (Messner et al. 2017).

Although Westslope Cutthroat Trout growth is slower in recent years than it was 50 years ago (Mallet 1963), catch rates are currently very high, and nearly one third (30%) of WCT caught are greater than 300 mm, compared to only 20% before catch-and-release regulations were imposed. This has produced one of the highest quality trout fisheries in the Salmon Region at present time. Hopefully with maintaining this dataset, we can detect any major community shifts that would affect the quality of the fishery and address them early.

It is important to ensure project anglers are diligent with keeping accurate and complete logs of their sampling on this trip, such as water conditions and angling times logged for CPUE calculations. In 2016, it is likely that the reason we calculated one of our lowest CPUE values was because of inaccurately recorded angling times. Additionally, as mentioned earlier for the 2017 trip, water conditions no doubt affect angling success, so keeping track of such conditions can help determine why some outliers exist in the data.

Lamprey Sampling

No Lamprey were captured at any sites in 2017 using the preset 8 setting on the LR-24 shocker (Table 30). At the Elk Bar site, settings were changed to operate on a dual frequency waveform. According to Thompson et al. (2010), dual frequencies should be used to sample for Lamprey ammocoetes; the first using a lower frequency to coax ammocoetes out of the sand/gravel, and the second used to reach tetany or immobilization for capture. Once settings were changed to operate with dual frequencies, at the Elk Bar site, we captured 25 Lamprey ammocoetes averaging 60.6 mm TL (range, 43-110 mm TL) (Figure 68). No Lamprey were captured at any other sites in 2017, regardless of settings used (Table 30).

MANAGEMENT RECOMMENDATIONS

1. Continue annual monitoring of Westslope Cutthroat Trout, Rainbow Trout/Steelhead, and juvenile Chinook Salmon in all 28 main stem sites, 10 tributary sites, and 6 historical mainstem MFSR sites by snorkeling between the second week of July and the third week of August.

2. Continue monitoring angling catch rates (fish/hour) every year on the Middle Fork Salmon River to assess trends and to provide up-to-date information for anglers, guides, and outfitters.

3. Use dual-frequency electrofishing settings for sampling Pacific Lamprey throughout the MFSR sampling locations.

Table 27. Densities of salmonids observed during snorkel surveys in the MFSR drainage in 2017 (fish/100m^2).

Site	Trout Fry	Rainbow Trout/ steelhead	Chinook Salmon Parr	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Historical main stem sites (Corley)							
Little Creek GS	0.00	0.35	18.51	4.32	0.00	0.00	2.42
Mahoney	0.00	0.00	15.00	7.08	0.00	0.00	5.00
White Creek PB	0.00	0.00	0.60	3.50	0.00	0.00	2.24
Bernard Airstrip	0.00	0.00	0.00	0.52	0.00	0.00	0.26
Hancock Pool	0.00	0.00	0.00	1.26	0.00	0.00	1.14
Cliffside Pool	0.00	0.00	0.89	0.36	0.00	0.00	0.07
Mean	0.00	0.06	5.83	2.84	0.00	0.00	1.86
SE	0.00	0.06	3.82	1.18	0.00	0.00	0.81
Minimum	0.00	0.00	0.00	0.36	0.00	0.00	0.07
Maximum	0.00	0.35	18.51	7.08	0.00	0.00	5.00
Traditional main stem sites							
Boundary	0.00	8.02	23.40	1.07	0.13	0.00	1.34
Gardell's	0.00	1.27	0.16	0.79	0.00	0.00	1.75
Velvet	0.00	10.14	53.21	10.98	0.00	0.00	10.14
Elkhorn	0.00	6.58	12.00	1.16	0.00	0.00	5.81
Sheepeater	0.00	2.29	3.76	0.65	0.16	0.00	1.14
Greyhound	0.00	4.86	21.37	2.72	0.00	0.00	2.91
Rapid R	0.00	8.29	27.02	7.99	0.61	0.00	10.44
Indian	0.00	2.43	1.86	6.15	0.00	0.00	8.01
Pungo	0.00	1.62	50.79	7.90	0.00	0.00	1.86
Marble Pool	0.00	2.77	18.25	4.80	0.00	0.00	5.12
Ski Jump	0.00	0.83	0.00	1.14	0.00	0.00	3.43
Lower Jackass	0.00	0.00	0.14	1.97	0.00	0.00	3.66
Cougar	0.00	0.42	0.42	1.25	0.00	0.00	2.92
Whitey Cox	0.00	0.33	9.00	1.96	0.00	0.00	0.65
Rock Island	0.00	0.00	0.00	0.27	0.00	0.00	0.55
Hospital Pool	-	-	-	-	-	-	-
Hospital Run	-	-	-	-	-	-	-
Tappan Pool	-	-	-	-	-	-	-
Flying B	0.00	0.00	0.00	0.33	0.00	0.00	0.33
Airstrip	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Survey	0.00	1.33	0.00	1.00	0.00	0.00	1.00
Big Cr PB	0.00	0.00	2.16	0.86	0.00	0.00	0.43
Love Bar	0.00	0.00	0.00	0.55	0.00	0.00	0.18
Ship Island	0.00	0.00	0.00	1.80	0.00	0.00	0.00
Little Ouzel	0.00	0.18	1.14	1.26	0.00	0.00	1.80

Table 27 (continued)

Site	Trout Fry	Rainbow Trout/ steelhead	Chinook Salmon Parr	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Otter Bar	0.00	0.13	0.00	0.94	0.00	0.00	0.94
Goat Pool	0.00	0.17	0.00	1.87	0.00	0.00	0.51
Goat Run	0.00	0.29	1.90	1.32	0.00	0.00	1.32
Mean	0.00	2.08	9.08	2.43	0.04	0.00	2.66
SE	0.00	0.62	3.14	0.58	0.03	0.00	0.62
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	10.14	53.21	10.98	0.61	0.00	10.44
Traditional tributary sites							
Big Creek L1	0.17	2.44	5.17	0.50	0.06	0.00	0.80
Indian LOWER	0.00	1.11	1.66	0.14	0.00	0.00	0.55
Indian UPPER	0.90	2.34	3.60	0.18	0.00	0.00	1.80
Loon L1-Bridge	0.00	0.80	8.65	0.32	0.16	0.00	1.76
Loon L-2 Run	0.00	1.74	6.77	0.69	0.17	0.00	0.69
Camas L1	0.00	0.80	8.79	0.64	0.08	0.00	1.45
Camas UPPER	0.00	0.09	4.43	0.54	0.00	0.00	0.80
Marble Lower	1.80	1.01	3.26	0.11	0.00	0.00	1.35
Pistol L1	0.00	4.65	12.29	1.00	0.00	0.00	1.00
Pistol L2	0.00	2.10	2.57	0.23	0.00	0.00	0.00
Mean	0.29	1.71	5.66	0.44	0.05	0.00	1.02
SE	0.20	0.43	1.10	0.10	0.02	0.00	0.19
Minimum	0.00	0.09	1.66	0.11	0.00	0.00	0.00
Maximum	1.80	4.65	12.29	1.00	0.17	0.00	1.80

Table 28. Summary of fish caught during angling surveys on the main stem MFSR, 1959 to 2017.

Year	WCT	RBT/ STHD	BLT	MWF	WCTxR BT	BUTxE BT	CHN	BT	NPM	SUC	RSS	Total # of fish	Total hours of effort	CPUE
1959	143	112	11	0	0	0	0	0	0	0	0	266	UNK	n/a
1960	484	103	94	0	0	0	0	0	0	0	0	681	UNK	n/a
1969[a]	166	-	-	-	-	-	-	-	-	-	-	166	UNK	n/a
1975	158	109	11	4	0	0	0	0	0	0	0	282	57.5	4.9
1976	75	14	2	2	0	0	0	0	0	0	0	93	UNK	n/a
1978	160	91	0	13	0	0	0	0	0	0	0	264	86.0	3.1
1979	139	112	0	0	0	0	0	0	0	0	0	251	UNK	n/a
1990	735	339	2	0	0	0	0	0	0	0	0	1076	UNK	n/a
1991	42	54	0	0	3	0	0	0	0	0	0	99	UNK	n/a
1992	42	53	0	1	0	0	0	0	0	2	0	98	UNK	n/a
1993	242	66	0	0	6	0	0	0	0	0	0	314	UNK	n/a
1999	182	132	0	0	8	0	0	0	0	0	0	322	UNK	n/a
2003	167	91	0	0	0	0	1	0	0	0	1	260	UNK	n/a
2004	243	184	1	0	0	0	1	0	1	0	0	430	UNK	n/a
2005	226	157	7	2	4	0	0	0	5	0	0	401	UNK	n/a
2007	264	253	2	6	1	0	0	0	16	0	0	542	UNK	n/a
2008	64	90	0	0	1	0	0	0	0	0	0	155	26.9	5.8
2009	340	230	2	4	8	0	0	1	14	0	2	601	166.0	3.6
2010	174	115	8	21	3	0	2	2	0	0	0	325	116.2	2.8
2011	109	47	0	6	0	0	0	0	0	0	0	162	42.0	3.9
2012	299	206	11	14	4	0	0	0	5	1	1	541	145.9	3.7
2013	200	195	1	6	1	1	3	0	9	0	0	416	102.0	4.1
2014	167	137	3	7	1	1	0	0	6	3	2	327	98.7	3.3
2015	214	179	3	12	10	0	29	0	8	0	0	455	104.9	4.3
2016	270	192	0	2	11	0	0	0	9	0	2	486	156.5	3.1
2017	247	99	1	1	4	0	6	0	5	0	1	364	105.2	3.5

[a] Only WCT enumerated

WCT = Westslope Cutthroat Trout, RBT/STHD = Rainbow Trout/Steelhead, BLT = Bull Trout, MWF = Mountain Whitefish, CHN = Chinook Salmon, BT = Brook Trout, NPM = Northern Pikeminnow, SUC = Sucker spp., RSS = Redside Shiner.

CPUE = fish/h

Table 29. Percentage of each salmonid species represented in total catch during angling surveys on the mainstem MFSR, 1959 to 2017. 1969 was omitted due to only enumerating WCT that year.

Year	WCT	RBT/STHD	BUT	BT	MWF	WCTxRBT	BLTxBT
1959	54%	42%	4%	0%	0%	0%	0%
1960	71%	15%	14%	0%	0%	0%	0%
1975	56%	39%	4%	1%	0%	0%	0%
1976	81%	15%	2%	2%	0%	0%	0%
1978	61%	34%	0%	5%	0%	0%	0%
1979	55%	45%	0%	0%	0%	0%	0%
1990	68%	32%	0%	0%	0%	0%	0%
1991	42%	55%	0%	0%	3%	0%	0%
1992	43%	54%	0%	1%	0%	0%	0%
1993	77%	21%	0%	0%	2%	0%	0%
1999	57%	41%	0%	0%	2%	0%	0%
2003	64%	35%	0%	0%	0%	0%	0%
2004	57%	43%	0%	0%	0%	0%	0%
2005	56%	39%	2%	0%	1%	0%	0%
2007	49%	47%	0%	1%	0%	0%	0%
2008	41%	58%	0%	0%	1%	0%	0%
2009	57%	38%	0%	1%	1%	0%	0%
2010	54%	35%	2%	6%	1%	0%	1%
2011	67%	29%	0%	4%	0%	0%	0%
2012	55%	38%	2%	3%	1%	0%	0%
2013	48%	47%	0%	1%	0%	0%	1%
2014	51%	42%	1%	2%	0%	0%	0%
2015	47%	39%	1%	3%	2%	0%	6%
2016	56%	40%	0%	0%	2%	0%	0%
2017	68%	27%	0%	0%	1%	0%	0%
mean	57%	38%	1%	1%	1%	0%	0%

WCT = Westslope Cutthroat Trout, RBT/STHD= Rainbow Trout/Steelhead, BLT= Bull Trout, MWF = Mountain Whitefish, BT = Brook Trout.

Table 30. Main stem MFSR sites electrofished for Lamprey ammocoetes in 2017.

Date	Site name	Location	Site length (m)	Latitude	Longitude	Time of day	Time sampled (sec)	Settings	Total caught
7/27/2017	Indian Creek	river right1	40	44.73234	-115.14445	10:35	202	preset 8	0
7/27/2017	Indian Creek	river right2	50	44.73545	-115.14058	11:15	226	preset 8	0
7/27/2017	Indian Creek	Put in	--	44.75732	-115.11301	11:55	547	preset 8	0
7/28/2017	Jackass	ds of jackass rapids	30	44.72256	-114.96174	11:30	270	preset 8	0
7/28/2017	White Creek	White creek camp	50	44.79280	-114.84151	16:15	424	preset 8	0
7/29/2017	Little Arapajo	ds of little arapajo	30	44.82131	-114.80418	10:05	160	preset 8	0
7/29/2017	Little Bear Cr	200ft us of Little Bear Cr	60	44.92222	-114.73283	16:20	362	preset 8	0
7/30/2017	Flying B	us of Flying B	100	44.95733	-114.73402	11:40	393	preset 8	0
7/30/2017	Bernard	Bernard Airstrip	60	44.98515	-114.73174	12:40	204	preset 8	0
7/30/2017	Big Creek Pack Br	50m us of pack br	15	45.09369	-114.73196	--	322	preset 8	0
7/31/2017	Elk Bar	river left	--	45.11420	-114.72579	9:40	938	preset 8	0
7/31/2017	Elk Bar	off-channel pool	30	45.11420	-114.72579	10:30	1393	dual frequency	25
7/31/2017	Elk Bar	river right	35	45.12120	-114.72132	11:50	204	dual frequency	0
7/31/2017	below Ship Island	river right	35	45.18164	-114.71984	13:45	118	dual frequency	0
7/31/2017	Parrot Placer	river right	100	45.19091	-114.69617	15:00	447	dual frequency	0
7/31/2017	Stoddard camp	river left	80	45.23408	-114.67555	16:40	371	dual frequency	0
8/1/2017	Below Rubber	river right	40	45.25131	-114.65439	10:10	115	dual frequency	0

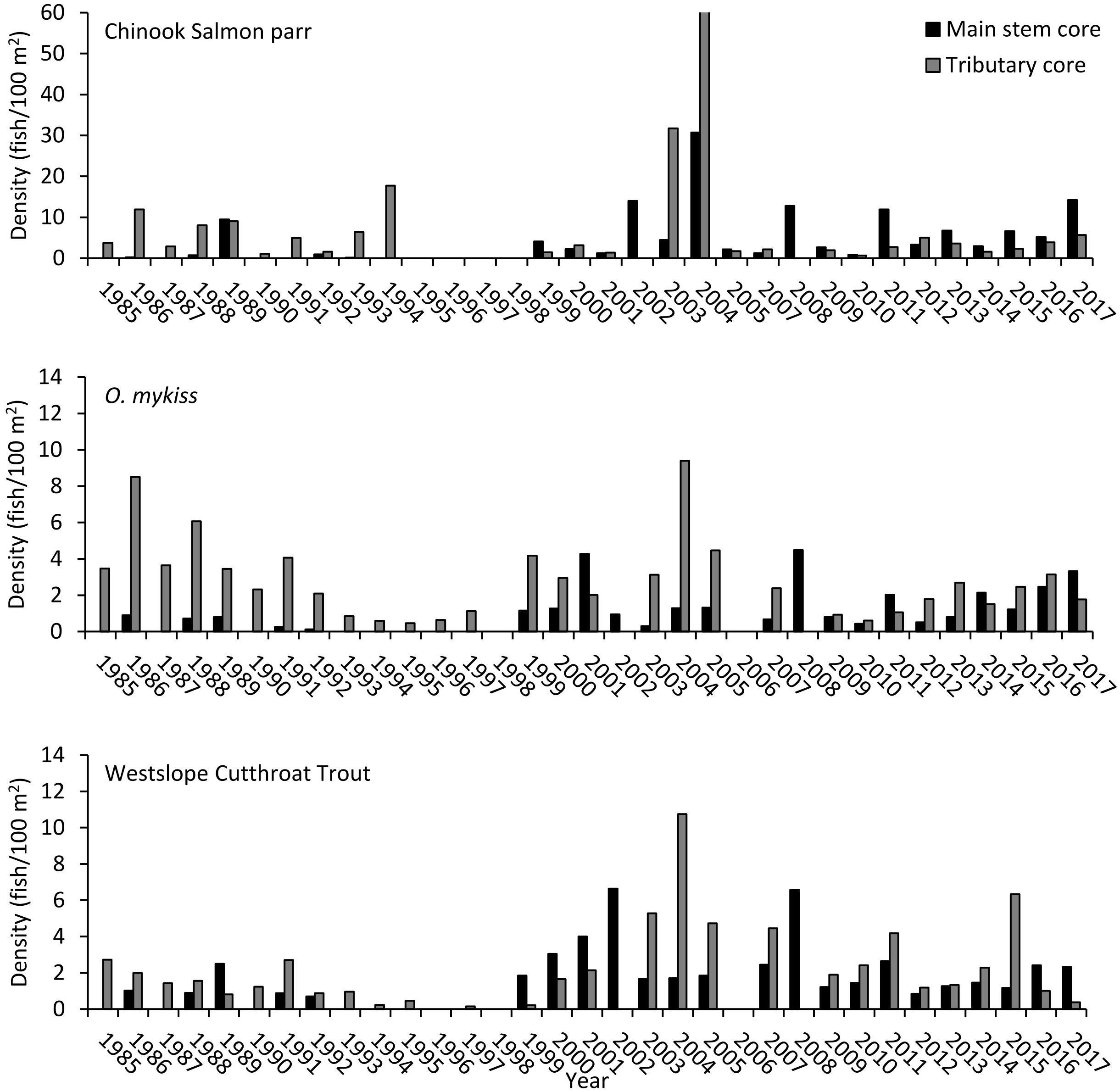

Figure 59. Overall mean densities of Chinook Salmon parr, Rainbow Trout/steelhead, and Westslope Cutthroat Trout observed during snorkel surveys at MFSR traditional main stem and traditional tributary sites, 1986 to 2017. Note varying scale on y-axes.

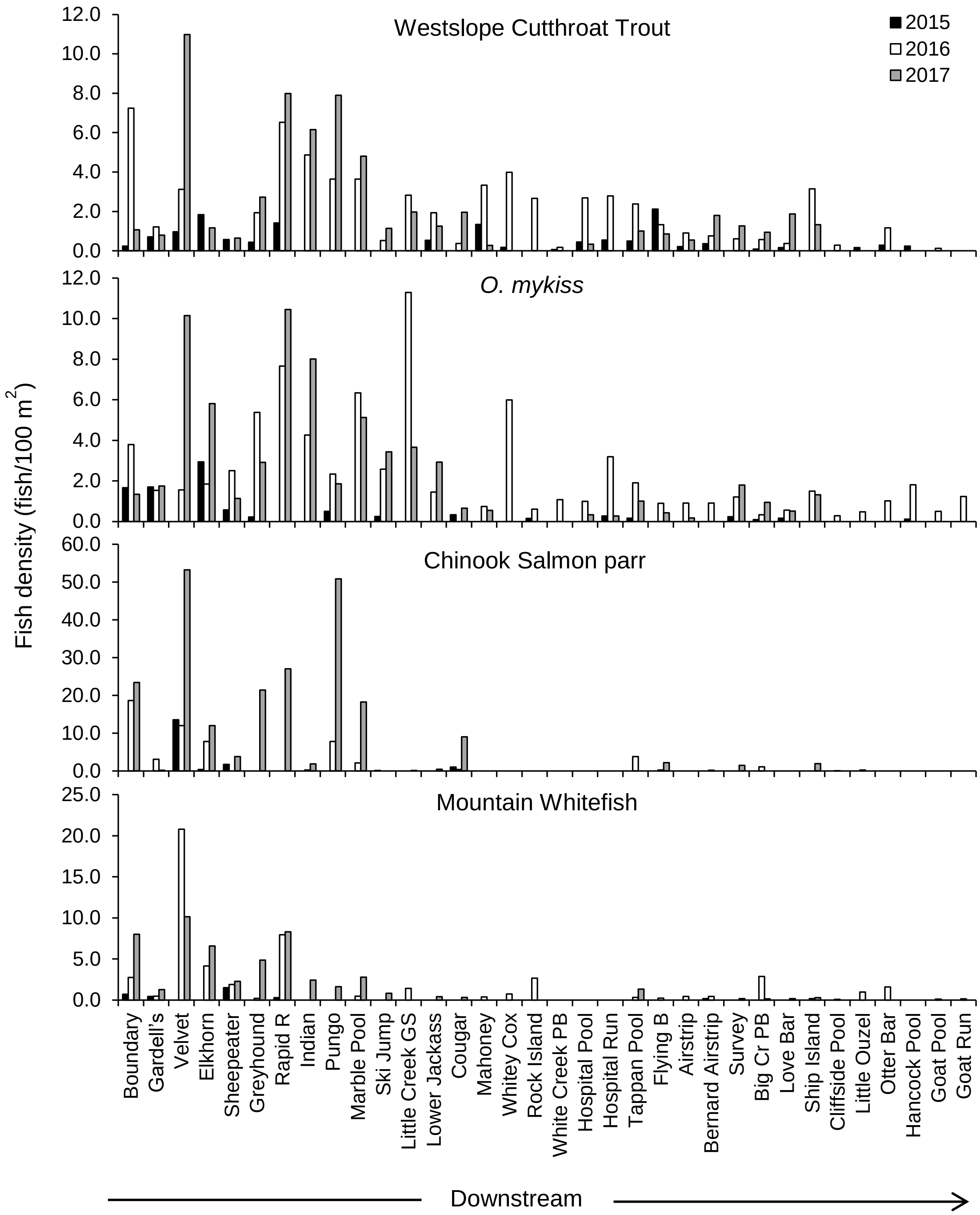

Figure 60. Salmonid densities by site in the main stem MFSR, 2015 through 2017. Note varying scales for y-axes.

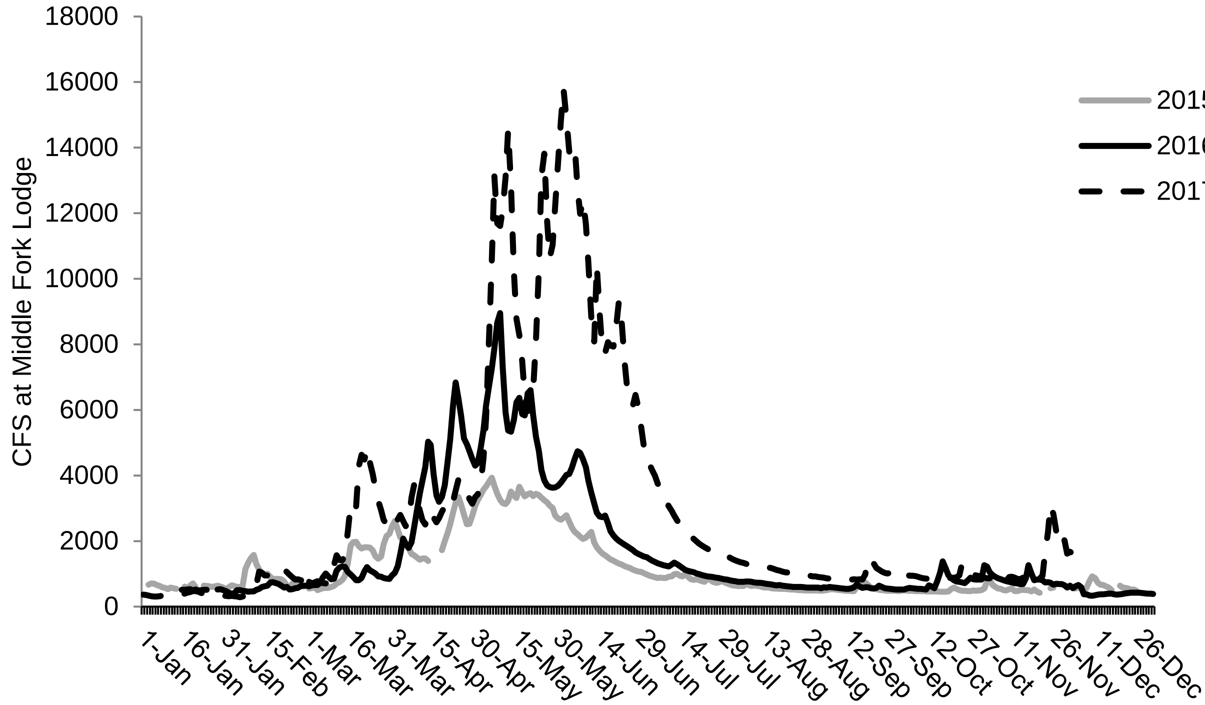

Figure 61. Daily discharge (cfs) for the Middle Fork Salmon River at Middle Fork Lodge (mile 33.3 from Boundary Creek put-in), 2015 – 2017.

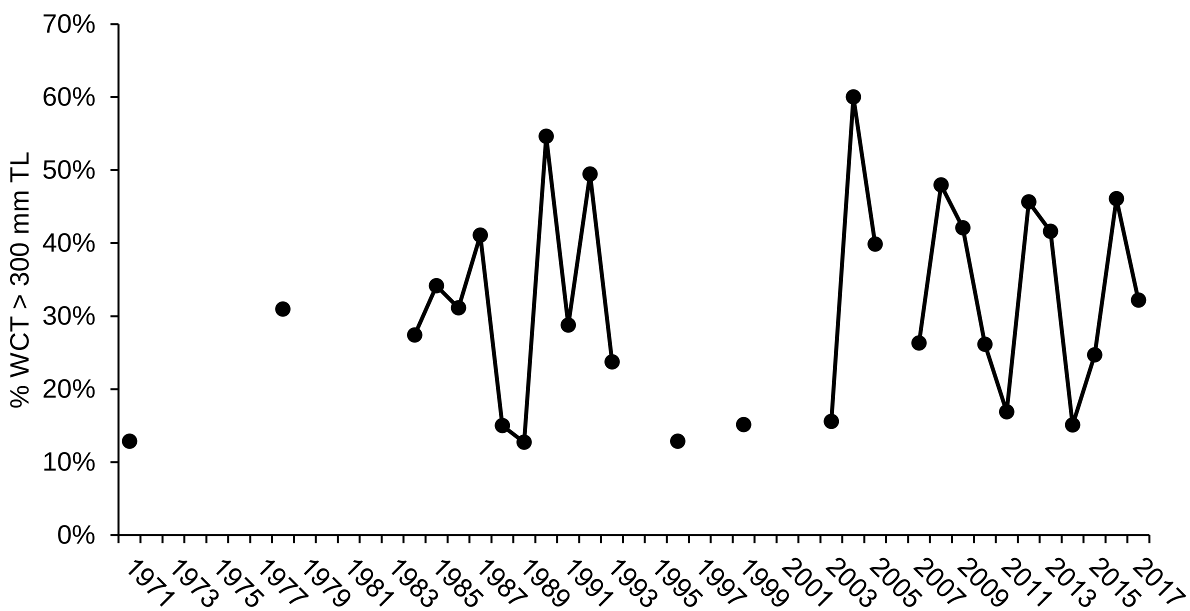

Figure 62. Percentage of Westslope Cutthroat Trout greater than 300 mm TL observed during snorkel surveys in the main stem MFSR, 1971 to 2016.

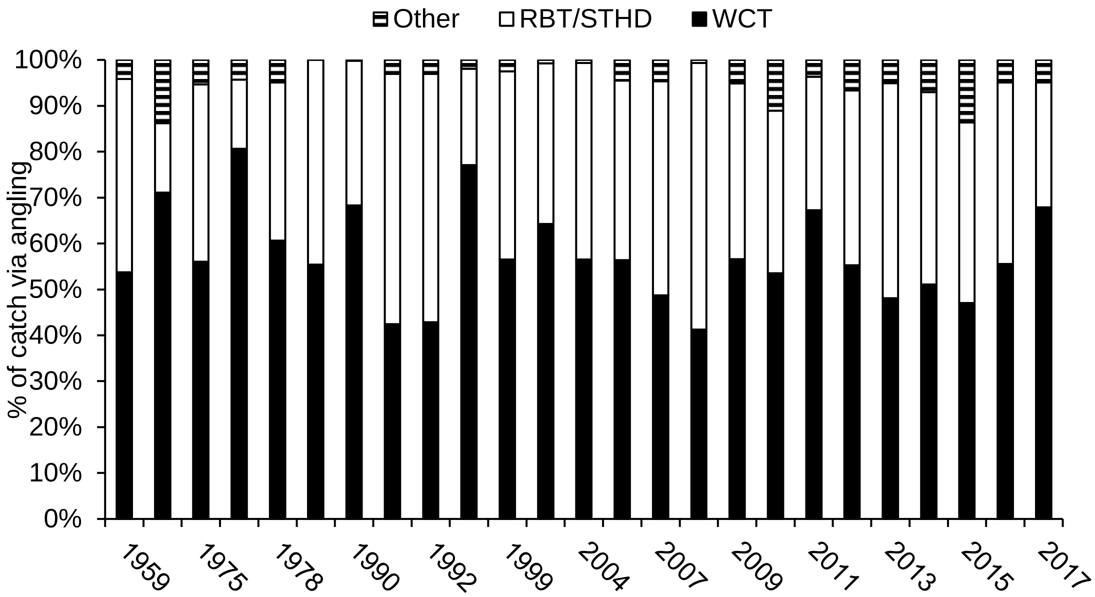

Figure 63. Percentage of Rainbow Trout/Steelhead (RBT/STHD), Westslope Cutthroat Trout (WCT), and other species (Other) represented in total angler catch during angling surveys on the mainstem MFSR, 1959 to 2017.

Figure 64. Catch per unit effort (CPUE) (# of fish caught per angler hour) estimated from hook and line sampling on the Middle Fork of the Salmon River between 2008 and 2017. The dotted line represents the mean (3.9 fish per angler hour) CPUE estimated over this time period.

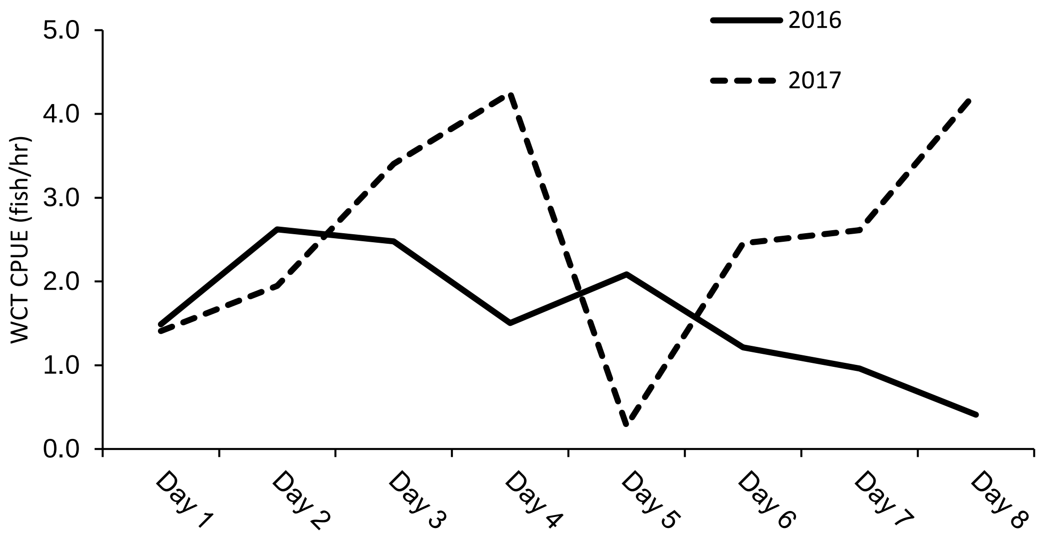

Figure 65. Daily Westslope Cutthroat Trout catch rate (CPUE fish/h) during angling surveys on the main stem MFSR in 2016 and 2017.

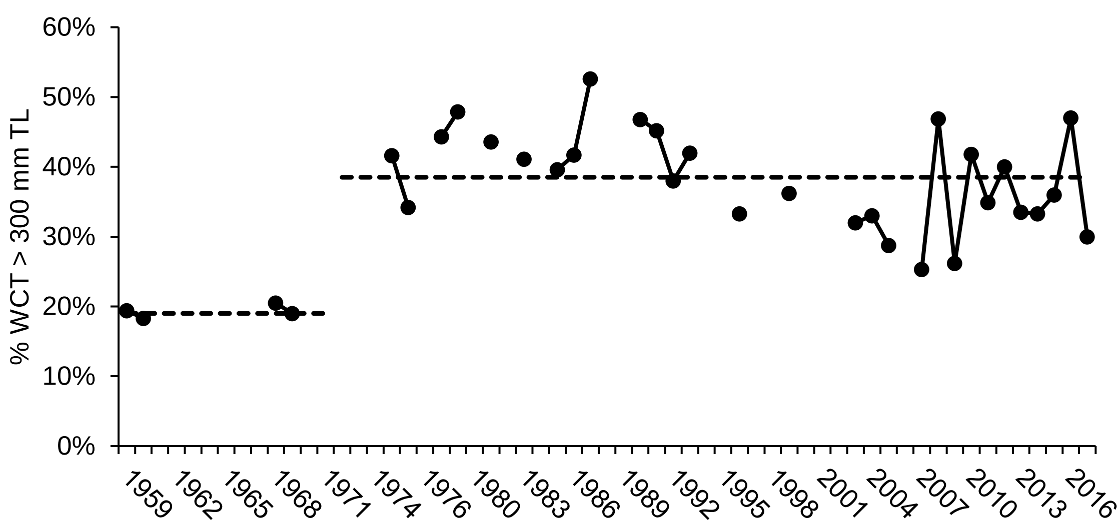

Figure 66. Percentage of Westslope Cutthroat Trout greater than 300 mm TL caught during angling surveys on the Middle Fork Salmon River, 1959 to 2017. The two dashed lines represent average proportions prior to 1972 (during harvest) and post-1972 (C&R only).

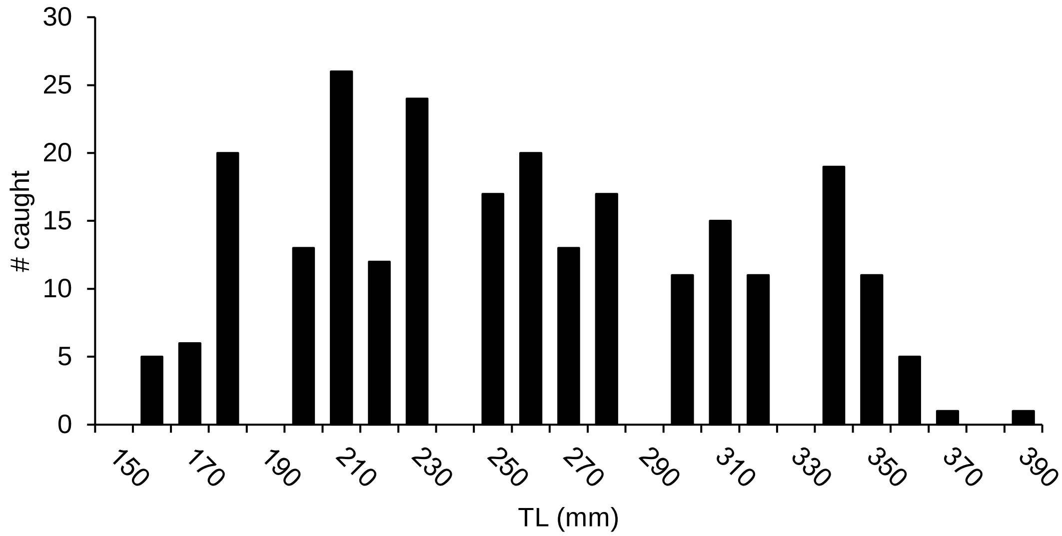

Figure 67. Length-frequency histogram of Westslope Cutthroat Trout caught during angling surveys in 2017 on the Middle Fork Salmon River.

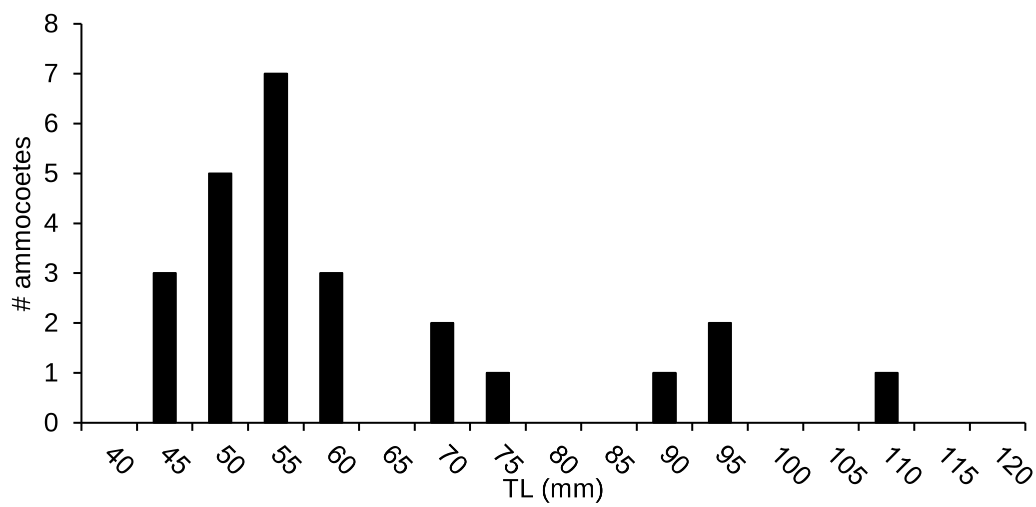

Figure 68. Length-frequency histogram of Pacific Lamprey ammocoetes captured at the Elk Bar site on the MFSR in 2017. This is the only site where Lamprey were captured in 2017.

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APPENDICES

Appendix A Intercept (*a*) and slope (*b*) parameters for standard weight (W_s) equations, taken from Blackwell et al. (2000). $Log_{10}(W_s) = a' + b * Log_{10}(\text{total length (mm)})$

Species	Intercept (*a*)	Slope (*b*)	Minimum TL (mm)	Source
Cutthroat Trout (lotic)	-5.192	3.086	130	Kruse and Hubert, 1997
Cutthroat Trout (lentic)	-5.189	3.099	130	Kruse and Hubert, 1997
Lake Trout	-5.681	3.246	280	Piccolo et al., 1993
Tiger muskellunge	-6.126	3.337	240	Rogers and Koupal, 1997
Rainbow Trout (lentic)	-4.898	2.99	120	Simpkins and Hubert, 1996
Rainbow Trout (lotic)	-5.023	3.024	120	Simpkins and Hubert, 1996

Appendix B. Wild trout redd count trend transect coordinates and lengths.

Species/ Transect	Year established	Start Latitude (°N)	Start Longitude (°W)	End Latitude (°N)	End Longitude (°W)	Length (km)
		Rainbow Trout				
Big Springs Creek - Tyler	1994	44.70896	113.39917	44.72855	113.43430	3.4
Big Springs Creek - Neibaur	1994	44.70047	113.38436	44.70896	113.39917	4.5
Upper Lemhi River	1994	44.68689	113.36273	44.69945	113.37074	3.0
		Bull Trout				
Alpine Creek - upper	1998	43.90705	114.93078	43.90357	114.94457	1.5
Alpine Creek - lower	2010	43.89707	114.91327	43.90245	114.92246	1.5
Fishhook Creek - upper	1998	44.13706	114.96703	44.13472	114.97622	1.0
Fishhook Creek -lower	2008	44.14882	114.93716	44.13992	114.96205	3.5
Fourth of July Creek	2003	44.04112	114.75831	44.05039	114.69165	5.0
Hayden Creek	2010	44.70624	113.73430	44.37053	113.75771	2.5
Bear Valley Creek - upper	2007	44.78332	113.75496	44.79685	113.80820	4.7
Bear Valley Creek - lower	2002	44.77624	113.74259	44.78332	113.75496	1.7
East Fork Hayden Creek	2002	44.72984	113.67145	44.72438	113.66671	1.5

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